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Technical manual

LioN-P EtherCAT® Multiprotocol
0980 ESL 391-111
0980 ESL 392-111
0980 ESL 393-111
0980 ESL 391-121
0980 ESL 392-121
0980 ESL 393-121
0980 ESL 393-121-DCU1

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1 About this manual

1.1 General information

Please read the assembly and operating instructions in this manual carefully before starting up the LioN-P modules with EtherCAT® interface. 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 LioN-P modules with EtherCAT® interface.

Please contact us if you have any detailed questions on installing and starting up the devices. We will be happy to help you.

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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 NOTE
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.

1.2.3 EtherCAT® trademark information

EtherCAT® is registered trademark and patented technology, licensed by Beckhoff Automation GmbH, Germany

1.3 Version information

Index	Created	Changed
Version number	Version 1.0	
Date	November 2016	
Name/department	MJ/R&D	
Version number		
Date		
Name/department		

Table 1: Overview of manual revisions

1.4 Designations and synonyms

Designation / Synonym	Description
PDO	Process Data Object
TxPDO	Transmit Process Data Object (IO-device to controller)
RxPDO	Receive Process Data Object (Controller to IO- device)
USINT	Unsigned 8 Bit value
UDINT	Unsigned 32 Bit value
EC	EtherCAT®
X1A...X8A	Channel A (contact pin 4) of X1 to X8
X1B...X8B	Channel B (contact pin 2) of X1 to X8

Table 2: Designations and synonyms

2 Safety instructions

2.1 Intended use

The devices described in this manual are decentralized input/output modules on an EtherCAT® 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 modules 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.

NOTE
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.

A completely assembled device housing is required for the proper operation of the modules. Only connect devices to the modules that fulfill the requirements of EN 61558-2-4 and EN 61558-2-6.

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.

3 System description

3.1 About the LioN-P module series

LioN modules (Lumberg input/output Network) function as the interface in an industrial fieldbus system: They enable a central controller on the management level to communicate with the decentralized sensors and actuators on the field level. The line topologies (logical ring topology only for EtherCAT®) can be used to create not only ensure reliable data communication but also significantly reduce the cables required and thus also the costs for installation and maintenance. They additionally enable easy, quick extension.

The modules of the LioN-P series have a very sturdy metal housing made of die-cast zinc. The completely cast device housing protects the module electronics from environmental effects and allows the device to be used in a wide temperature range. Despite the sturdy construction, the modules have compact dimensions and a low weight. They are especially suitable for use in machines and installations with a moderate I/O concentration over separate assemblies.

3.2 Special product features

- Robust design:

  The connection option provided by the module series is the widely-used M12 connector with A coding for the I/O signals and D coding for the network. The connectors are also color-coded to prevent the ports from being mixed up. The output power circuits are electrically isolated from the rest of the network and the sensor electronics. This reliably protects the control devices from interference signals.

- Integrated switch:

  The integrated 2-port Ethernet switch of the modules allows a line topology to be set up for the EtherCAT® network.

- Failsafe function:

  The modules with output functions (variants 16DO and 8DI/8DO) provide a failsafe function. This allows you to define the behavior of every single output channel in the case of an interruption or a loss of communication.

- Integrated web server:

  The integrated web server provides status information, forcing of the inputs and outputs for installation, checks and firmware update functionality.

- Multiprotocol support:

  The multiprotocol modules allow you to select different protocols for communication within a fieldbus system. In this way the multiprotocol modules can be integrated into different networks without it being necessary to purchase modules specific for each protocol.

3.3 Product overview

The LioN-P module series consists of 3 variants of modules with different I/O functions. Detailed information is provided in the following table.

Item number	Description	I/O ports	Design
LioN-P module with 16 digital inputs			
0980 ESL 391-111 Order number: 934 882-001 (7/8'' power, multiprotocol) 0980 ESL 391-121 Order number: 934 879-001 (M12 power, multiprotocol)	16DI	8 x M12	Sturdy/metal
LioN-P module with 16 digital outputs			
0980 ESL 392-111 Order number: 934 882-002 (7/8'' power, multiprotocol) 0980 ESL 392-121 Order number: 934 879-002 (M12 power, multiprotocol)	16DO	8 x M12	Sturdy/metal

Table 3: Overview of module variants of the LioN-P series

Item number	Description	I/O ports	Design
LioN-P module with 8 digital inputs and 8 digital outputs			
0980 ESL 393-111 Order number: 934 882-003 (7/8'' power, multiprotocol) 0980 ESL 393-121 Order number: 934 879-003 (M12 power, multiprotocol) 0980 ESL 393-121-DCU1 Order number: 934 879-005 (M12 power, multiprotocol with distributed control unit)	8DI/8DO	8 x M12	Sturdy/metal

Table 3: Overview of module variants of the LioN-P series

4 Assembly and wiring

4.1 General information

Mount the module with 2 screws (M4x25/30) for LioN-P on a level surface. The torque required here is 1 Nm. Use washers for all fastening methods as per DIN 125. For the mounting holes, use a distance of 190.3 to 191.8 mm for LioN-P modules with 7/8" connector/socket, and a distance of 196.8mm to 198.3 mm for LioN-P modules with M12 power L-coded.

Note
The modules 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 "XE"

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

Note
If the mounting surface not grounded, use a ground strap or a suitable PE line. Use an M4 screw to connect the ground strap or the PE line to the ground point and if possible put a washer and a toothed washer below the fixing screw.

Note

For UL application:
Be sure to use a UL-certified cable with a suitable evaluation to connect the devices (CYJV or PVVA). To program the control, please see the OEM information, and only use suitable accessories.

Note

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

WARNING

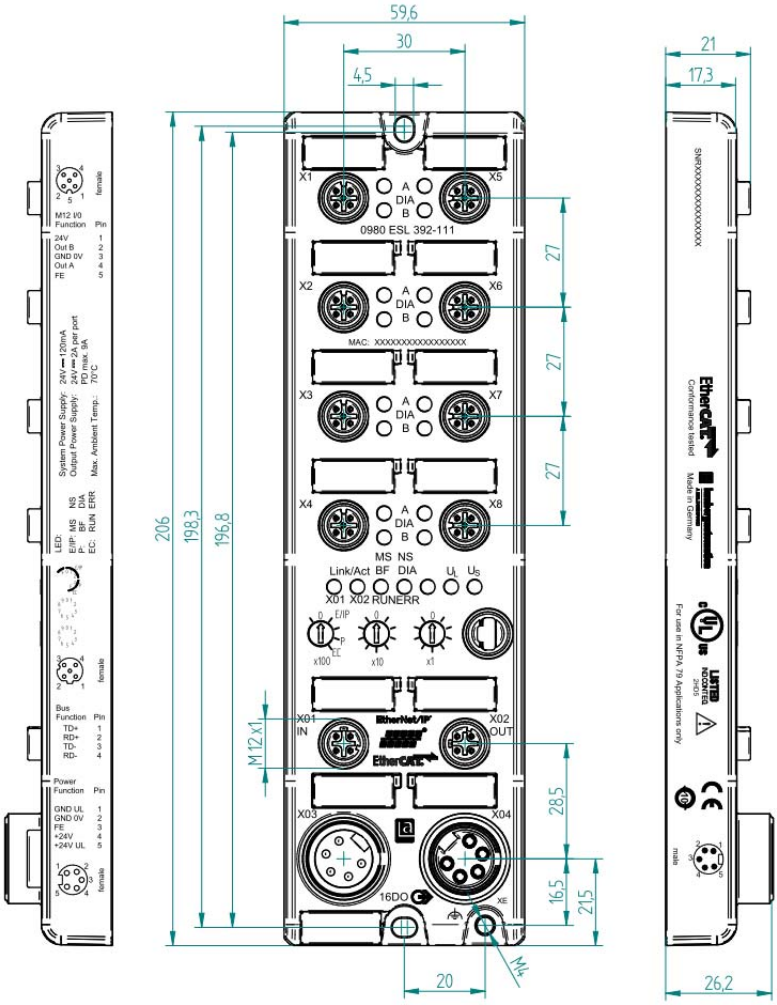
Terminals, housings field-wired terminal boxes or components can exceed temperatures of 60 °C.

WARNING

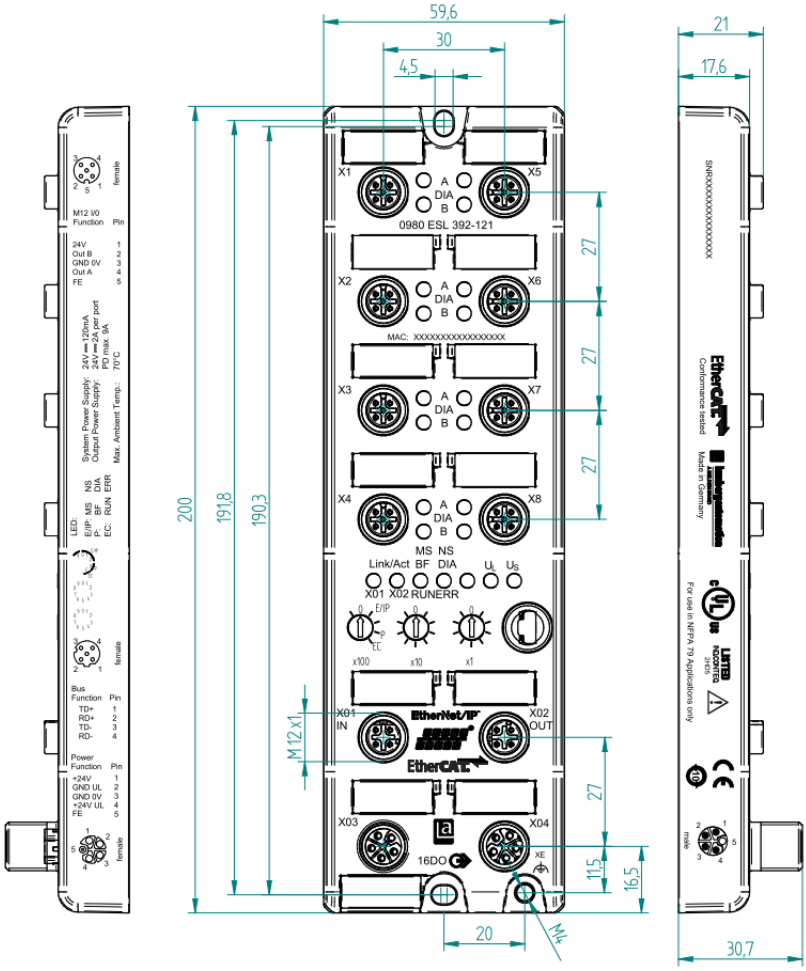
For UL application:
Use temperature-resistant cables with the following properties:
For the modules 0980ESL3x1-111 and 0980 ESL3x1-121 heat-resistant up to at least 85 °C.
For the modules 0980ESL3x2-1x1 and 0980 ESL3x3-1x1 heat-resistant up to at least 96 °C.

4.2 Outer dimensions

4.2.1 Module 0980 ESL 39x-111



4.2.2 Module 0980 ESL 39x-121



4.3 Port assignments

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

4.3.1 EtherCAT® ports

- Design: M12 socket, 4-pin, D-coded
- Color coding: green

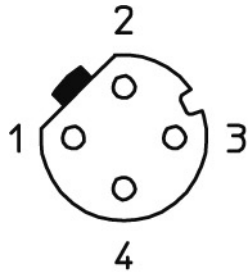


Figure 1: Schematic drawing, ports X01, X02

Port	Pin	Signal	Function
EtherCAT® Ports X01 (IN), X02 (OUT)	1	TD+	Transmit Data +
	2	RD+	Receive Data +
	3	TD-	Transmit Data -
	4	RD-	Receive Data -

Table 4: Assignment of ports X01, X02

⚠ Caution

Risk of destruction! Never connect the power supply to the data cables.

4.3.2 Connections for power supply, 7/8", 5-pin

▶ Color coding: gray

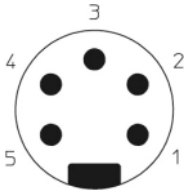


Figure 2: Schematic drawing, port X03 (IN)

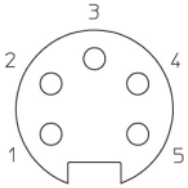


Figure 3: Schematic drawing, port X04 (OUT)

Port	Pin	Signal	Signal	Function
		0980 ESL 391-111	0980 ESL 392-111 0980 ESL 393-111	
Power supply X03, X04	1	*see note	GND_U_L (0V)	Actuator
	2	GND (0V)	GND_U_S (0V)	System/sensors
	3	FE	FE	Functional earth
	4	+24 V	U_S +24 V	System/sensors
	5	*see note	U_L (+24 V)	Actuator

Table 5: Assignment of ports X03, X04

NOTE

For the input module 0980 ESL 391-111, the two contacts 1 and 5 are not required for the actuators' power supply. However, these two contacts are connected to each other on the connector and socket side to enable 5-pin transmission of the power supply to a downstream module.

NOTE

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.

4.3.3 Power supply with M12 power L-coded

- Color coding: gray

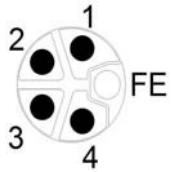


Figure 4: Schematic diagram of the M12 L-coding (connector), port X03 (IN)

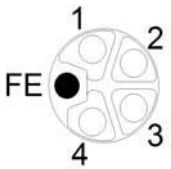


Figure 5: Schematic diagram of the M12 L-coding (socket), port X04 (OUT)

Port	Pin	Signal 0980 ESL 391-121	Signal 0980 ESL 392-121 0980 ESL 393-121	Function
Power supply X03, X04	1	U_S (+24V)	U_S (+24V)	System/sensors
	2	* see note	GND_U_L	Actuator
	3	GND_U_S	GND_U_S	System/sensors
	4	* see note	U_L (+24V)	Actuator
	FE (5)	FE	FE	Functional earth

Table 6: Assignment of X03, X04

NOTE

For the input module 0980 ESL 391-121, the two contacts 2 and 4 are not required for connecting the actuators' power supply. However, these two contacts are connected to each other on the connector and socket side to enable 5-pin transmission of the power supply to a downstream module.

NOTE

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.

4.3.4 Ports for the sensors/actuators

- Design: M12 socket, 5-pin
- Color coding: black

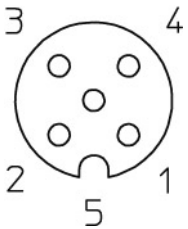


Figure 6: Schematic drawing, ports X1 to X8

Port	Pin	Function – 16DI 0980 ESL 391-111 0980 ESL 391-121	Function – 16DO 0980 ESL 392-111 0980 ESL 392-121	Function – 8DI/8DO 0980 ESL 393-111 0980 ESL 393-121 0980 ESL 393-121-DCU1	
Sensor/actuator	1	+24 V DC	n.c.	+24V DC nc	(port X1…X4) (port X5…X8)
	2	IN B	OUT B	IN B OUT B	(port X1…X4) (port X5…X8)
	3	GND U_S	GND U_L	GND_U_S GND_U_L	(port X1...X4) (port X5...X8)
	4	IN A	OUT A	IN A OUT A	(port X1…X4) (port X5…X8)
	5	FE / Func. earth	FE / Func. earth	FE / Func. earth	

Table 7: Assignment of ports X1 to X8

5 Starting operation

5.1 Downloading and installing the ESI file

An EtherCAT® Slave Information File (ESI) file is required for the configuration of a module in the controller. All module variants are supported by one ESI file. You have the option of downloading the EDS file from our website or asking our support team to send it to you. The address of the website is:

http://www.beldensolutions.com/en/Service/download_center/

The file for the LioN-P EtherCAT® modules is named

▶ **LumbergAutomation-LioN-P-Digital-IO.xml**

Install the ESI file for the module variant used with the aid of the hardware or network configuration tool of your controller manufacturer.

For TwinCat® the ESI file normaly has to be copied to the installation folder, e.g.: `C:\TwinCAT\3.1\Config\Io\EtherCAT`.

After the installation (TwinCAT® needs a restart), the modules are available in the hardware catalogs.

5.2 Reading the MAC addresses

Every module has a unique MAC address assigned by the manufacturer that cannot be changed by the user. The assigned MAC address is printed on the front side of the module.

For EtherCAT® this MAC address has no function. For EoE (Ethernet over EtherCAT®) a virtual MAC address will be assigned for the I/O-module.

5.3 Setting the rotary switches

As the EtherCAT® devices are multiprotocol devices, it's required to set the X100 rotary switch in front of the module to position EC for the EtherCAT protocol. After the power supply is restored, the modules read the switch settings.

The X10 and X1 rotary switches are not used for EtherCAT®.

Only the address setting 979 is used for a factory reset of the device.

Using the rotary encoding switches, the following settings are possible for LioN-P EtherCAT® modules:

Rotary switch setting	Function
000 (state on delivery)	X100 = 0, Ethernet/IP In the state on delivery, the DHCP and BOOTP functions are activated. The network parameters are initially requested via DHCP requests. If this is not successful, BOOTP requests are used. The network parameters are not saved, but the integrated web server can be used to save them.
000 (network parameters already saved)	X100 = 0, Ethernet/IP The network parameters last saved are used (IP address, subnet mask, gateway address, DHCP on/off, BOOTP on/off).
4xx (EC-x-x)	The EtherCAT protocol will be started after power-up, if no other protocol setting is stored in the non volatile memory of the module. (state on delivery) If the device was used for another protocol before, a factory reset is required before the EtherCAT protocol can be used.
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 8: Setting options of the rotary encoding switches for LioN-P modules

For additional multiprotocol information refer the manual
Manual_LioN_P_Multiprotocol_EN.pdf

5.4 Configuring the controller

5.4.1 PDO Assignments

The module supports different PDO assignments for input and output data.There are assignments for bit or byte access and with or without diagnosis data attached to the input data (TxPDO, I/O-module to controller. By selecting the relevant PDO, you decide your preferred data content.

The modules provide the following PDO assingments:

5.4.2 PDO's for 16DI modules: 0980 ESL 391-xxx

The PDO's 0x1A00 or 0x1A01 can be selected for the input data of the module.

PDO 0x1A00, Input data in byte format

PDO		PDO Content			
Index	Size	Index	Size	Type	Name
0x1A00	2	0x6000:01	1.0	USINT	Port X1A..X4B (see table 10)
		0x6000:02	1.0	USINT	Port X5A..X8B (see table 10)

Table 9: Input data in byte format

Content of Port X1A..X4B and Port X5A..X8B:

Index	Bit 7	Bit 6	Bit5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0x6000:01	X4B	X4A	X3B	X3A	X2B	X2A	X1B	X1A
0x6000:02	X8B	X8A	X7B	X7A	X6B	X6A	X5B	X5A

Table 10: Bit assignment for input data in byte format

- X1A...X8A: Input status, channel A (contact pin 4) of slots X1 to X8
- X1B...X8B: Input status, channel B (contact pin 2) of slots X1 to X8

PDO 0x1A01, Input data in bit format

PDO		PDO Content			
Index	Size	Index	Size	Type	Name
0x1A01	2	0x6020:01	0.1	BIT	Port X1A
		0x6020:02	0.1	BIT	Port X1B
		0x6020:03	0.1	BIT	Port X2A
		0x6020:04	0.1	BIT	Port X2B
		0x6020:05	0.1	BIT	Port X3A
		0x6020:06	0.1	BIT	Port X3B
		0x6020:07	0.1	BIT	Port X4A
		0x6020:08	0.1	BIT	Port X4B
		0x6020:09	0.1	BIT	Port X5A
		0x6020:0A	0.1	BIT	Port X5B
		0x6020:0B	0.1	BIT	Port X6A
		0x6020:0C	0.1	BIT	Port X6B
		0x6020:0D	0.1	BIT	Port X7A
		0x6020:0E	0.1	BIT	Port X7B
		0x6020:0F	0.1	BIT	Port X8A
		0x6020:10	0.1	BIT	Port X8B

Table 11: Input data in bit format

The PDO's 0x1A00 or 0x1A01 can be combined flexible with the PDO's 0x1A04 (Error register) and/or 0x1A05 (Diagnostic register).

PDO 0x1A04, Error register

PDO		PDO Content			
Index	Size	Index	Size	Type	Name
0x1A04	1	0x1001:01	1.0	USINT	Error Register

Table 12: Error register

Content of the error register:

B7	B6	B5	B4	B3	B2	B1	B0	Error description
0	0	0	0	0	0	0	0	No error
0	0	0	0	0	0	1	1	Output overload error, MI-SCS
0	0	0	0	0	1	0	1	Voltage error, MI-LVS
1	0	0	0	0	0	0	1	Additional function forcing, MI-FC
1	0	0	0	0	0	0	1	Additional function device diagn., MI-IME

Table 13: Bit content of error register

PDO 0x1A04, Diagnostic register

PDO		PDO Content			
Index	Size	Index	Size	Type	Name
0x1A05	4	0x2001:01	4.0	UDINT	Diagnostic register

Table 14: Diagnostic register

Content of the diagnostic register:

INPUT	Bit7	bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Byte 1	MI-IME	MI-FC	0	0	0	MI-SCS	0	MI-LVS
Byte 2	SCS-X5	SCS-X4	SCS-X3	SCS-X2	SCS-X4	SCS-X3	SCS-X2	SCS-X1
Byte 3	0	0	0	0	0	0	0	0
Byte 4	0	0	0	0	0	0	1	0

Table 15: Bit content of diagnostic register

Key

- **MI-LVS**: Module information byte – voltage for system/sensor power supply low
- **MI-SCS**: Module information byte – sensor short-circuit at an M12 slot
- **MI-FC**: Module information byte – forcing active
- **MI-IME**: Module information byte – internal module error
- **SCS-X1...SCS-X8**: sensor short-circuit at slot X1 to X8

5.4.3 16DO modules: 0980 ESL 392-xxx

The PDO's 0x1600 or 0x1601 can be selected for the output data of the module

PDO 0x1600, Output data in byte format

PDO		PDO Content			
Index	Size	Index	Size	Type	Name
0x1600	2	0x6200:01	1.0	USINT	Port X1A..X4B (see table 17)
		0x6200:02	1.0	USINT	Port X5A..X8B (see table 17)

Table 16: Input data in byte format

Content of Port X1A..X4B and Port X1A..X4B:

Index	Bit 7	Bit 6	Bit5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0x6200:01	X4B	X4A	X3B	X3A	X2B	X2A	X1B	X1A
0x6200:02	X8B	X8A	X7B	X7A	X6B	X6A	X5B	X5A

Table 17: Bit assignment for input data in byte format

- X1A...X8A: Output data, channel A (contact pin 4) of slots X1 to X8
- X1B...X8B: Output data, channel B (contact pin 2) of slots X1 to X8

PDO 0x1601, Output data in bit format

PDO		PDO Content			
Index	Size	Index	Size	Type	Name
0x1601	2	0x6220:01	0.1	BIT	Port X1A
		0x6220:02	0.1	BIT	Port X1B
		0x6220:03	0.1	BIT	Port X2A
		0x6220:04	0.1	BIT	Port X2B
		0x6220:05	0.1	BIT	Port X3A
		0x6220:06	0.1	BIT	Port X3B
		0x6220:07	0.1	BIT	Port X4A
		0x6220:08	0.1	BIT	Port X4B
		0x6220:09	0.1	BIT	Port X5A
		0x6220:0A	0.1	BIT	Port X5B
		0x6220:0B	0.1	BIT	Port X6A
		0x6220:0C	0.1	BIT	Port X6B
		0x6220:0D	0.1	BIT	Port X7A
		0x6220:0E	0.1	BIT	Port X7B
		0x6220:0F	0.1	BIT	Port X8A
		0x6220:10	0.1	BIT	Port X8B

Table 18: Input data in bit format

For the input data direction (TxPDO of the device) the following flexible selectable PDO's are available:

PDO 0x1A02, Output states in byte format

PDO		PDO Content			
Index	Size	Index	Size	Type	Name
0x1A00	2	0x2200:01	1.0	USINT	Port X1A..X4B (see table 20)
		0x2200:02	1.0	USINT	Port X5A..X8B (see table 20)

Table 19: Input data in byte format

Content of Port X1A..X4B and Port X5A..X8B:

Index	Bit 7	Bit 6	Bit5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0x2200:01	X4B	X4A	X3B	X3A	X2B	X2A	X1B	X1A
0x2200:02	X8B	X8A	X7B	X7A	X6B	X6A	X5B	X5A

Table 20: Bit assignment for output states in byte format

- X1A...X8A: Output status, channel A (contact pin 4) of slots X1 to X8
- X1B...X8B: Output status, channel B (contact pin 2) of slots X1 to X8

PDO 0x1A03, Output states in bit format

This object delivers (optional selectable) the real outputs states as input data (TxPDO) to the controller (Output Mirror):

PDO		PDO Content			
Index	Size	Index	Size	Type	Name
0x1A03	2	0x2020:01	0.1	BIT	Port X1A
		0x2020:02	0.1	BIT	Port X1B
		0x2020:03	0.1	BIT	Port X2A
		0x2020:04	0.1	BIT	Port X2B
		0x2020:05	0.1	BIT	Port X3A
		0x2020:06	0.1	BIT	Port X3B
		0x2020:07	0.1	BIT	Port X4A
		0x2020:08	0.1	BIT	Port X4B
		0x2020:09	0.1	BIT	Port X5A
		0x2020:0A	0.1	BIT	Port X5B
		0x2020:0B	0.1	BIT	Port X6A
		0x2020:0C	0.1	BIT	Port X6B
		0x2020:0D	0.1	BIT	Port X7A
		0x2020:0E	0.1	BIT	Port X7B
		0x2020:0F	0.1	BIT	Port X8A
		0x2020:10	0.1	BIT	Port X8B

Table 21: Input data in bit format

The PDO’s 0x1A02 or 0x1A03 can be combined flexible with the PDO’s 0x1A04 (Error register) and/or 0x1A05 (Diagnostic register).

PDO 0x1A04, Error register

PDO		PDO Content			
Index	Size	Index	Size	Type	Name
0x1A04	1	0x1001:01	1.0	USINT	Error register

Table 22: Error register

Content of the error register:

B7	B6	B5	B4	B3	B2	B1	B0	Error description
0	0	0	0	0	0	0	0	No error
0	0	0	0	0	0	1	1	Output overload error, MI-SCA
0	0	0	0	0	1	0	1	Voltage error, MI-LVS
0	0	0	0	0	1	0	1	Voltage error outputs, MI-LVA
1	0	0	0	0	0	0	1	Additional function forcing, MI-FC
1	0	0	0	0	0	0	1	Additional function device diagn., MI-IME

Table 23: Bit content of error register

PDO 0x1A04, Diagnostic register

PDO		PDO Content			
Index	Size	Index	Size	Type	Name
0x1A05	4	0x2001:01	4.0	UDINT	Diagnostic register

Table 24: Diagnostic register

Content of the diagnostic register:

INPUT	Bit7	bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Byte 1	MI-IME	MI-FC	0	0	MI-SCA	0	MI-LVA	MI-LVS
Byte 2	0	0	0	0	0	0	0	0
Byte 3	CE-X4B	CE-X4A	CE-X3B	CE-X3A	CE-X2B	CE-X2A	CE-X1B	CE-X1A
Byte 4	CE-X8B	CE-X8A	CE-X7B	CE-X7A	CE-X6A	CE-X6A	CE-X5B	CE-X5A

Table 25: Bit content of diagnostic register

Key

- **MI-LVS**: Module information byte – voltage for system/sensor power supply low
- **MI-LVA**: Module information byte – voltage for actuator low
- **MI-SCA**: Module information byte – actuator short-circuit

- **MI-FC**: Module information byte – forcing active
- **MI-IME**: Module information byte – internal module error
- **CE-X1A...CE-X8A**: Channel error,
  channel A (contact pin 4) of slots X1 to X8
- **CE-X1B...CE-X8B**: Channel error,
  channel B (contact pin 2) of slots X1 to X8

5.4.4 8DI/8DO modules: 0980 ESL 393-xxx

The PDO 0x1A00 or 0x1A01 can be selected for the input data of the module.

PDO 0x1A00, Input data in byte format

PDO		PDO Content			
Index	Size	Index	Size	Type	Name
0x1A00	2	0x6000:01	1.0	USINT	Port X1A..X4B (see table 27)

Table 26: Input data in byte format

Content of port X1A..X4B and port X5A..X8B:

Index	Bit 7	Bit 6	Bit5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0x6000:01	X4B	X4A	X3B	X3A	X2B	X2A	X1B	X1A

Table 27: Bit assignment for input data in byte format

- X1A...X8A: Input status, channel A (contact pin 4) of slots X1 to X8
- X1B...X8B: Input status, channel B (contact pin 2) of slots X1 to X8

PDO 0x1A01, Input data in bit format

PDO		PDO Content			
Index	Size	Index	Size	Type	Name
0x1A01	2	0x6020:01	0.1	BIT	Port X1A
		0x6020:02	0.1	BIT	Port X1B
		0x6020:03	0.1	BIT	Port X2A
		0x6020:04	0.1	BIT	Port X2B
		0x6020:05	0.1	BIT	Port X3A
		0x6020:06	0.1	BIT	Port X3B
		0x6020:07	0.1	BIT	Port X4A
		0x6020:08	0.1	BIT	Port X4B

Table 28: Input data in bit format

For the input data direction (TxPDO of the device) the following flexible selectable PDO's are available:

PDO 0x1A02, Output states in byte format

This object delivers (optional selectable) the real outputs states as input data to the controller (Output Mirror):

PDO		PDO Content			
Index	Size	Index	Size	Type	Name
0x1A00	2	0x2200:01	1.0	USINT	Port X5A..X8B (see table 30)

Table 29: Input data in byte format

Content of port X5A..X8B:

Index	Bit 7	Bit 6	Bit5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0x2200:01	X8B	X8A	X7B	X7A	X6B	X6A	X5B	X5A

Table 30: Bit assignment for output states in byte format

- X5A...X8A: Output state, channel A (contact pin 4) of slots X5 to X8
- X5B...X8B: Output state, channel B (contact pin 2) of slots X5 to X8

PDO 0x1A03, Output states in bit format

This object delivers (optional selectable) the real outputs states as input data to the controller (Output Mirror):

PDO		PDO Content			
Index	Size	Index	Size	Type	Name
0x1A03	2	0x2020:01	0.1	BIT	Port X5A
		0x2020:02	0.1	BIT	Port X5B
		0x2020:03	0.1	BIT	Port X6A
		0x2020:04	0.1	BIT	Port X6B
		0x2020:05	0.1	BIT	Port X7A
		0x2020:06	0.1	BIT	Port X7B
		0x2020:07	0.1	BIT	Port X8A
		0x2020:08	0.1	BIT	Port X8B

Table 31: Input data in bit format

The PDO's 0x1A01 or 0x1A02, 0x1A02 or 0x1A03 can be combined flexible with the PDO's 0x1A04 (Error register) and/or 0x1A05 (Diagnostic register)

PDO 0x1A04, Error register

PDO		PDO Content			
Index	Size	Index	Size	Type	Name
0x1A04	1	0x1001:01	1.0	USINT	Error register

Table 32: Error register

Content of the Error register:

B7	B6	B5	B4	B3	B2	B1	B0	Error description
0	0	0	0	0	0	0	0	No error
0	0	0	0	0	0	1	1	Output overload error, MI-SCS or MI-SCA
0	0	0	0	0	1	0	1	Voltage error, MI-LVS
0	0	0	0	0	1	0	1	Voltage error outputs, MI-LVA
1	0	0	0	0	0	0	1	Additional function forcing, MI-FC
1	0	0	0	0	0	0	1	Additional function device diagn., MI-IME

Table 33: Bit content of the error register

PDO 0x1A04, Diagnostic register

PDO		PDO Content			
Index	Size	Index	Size	Type	Name
0x1A05	4	0x2001:01	4.0	UDINT	Diagnostic register

Table 34: Diagnostic register

Content of the diagnostic register:

INPUT	Bit7	bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Byte 1	MI-IME	MI-FC	0	0	MI-SCA	MI-SCS	MI-LVA	MI-LVS
Byte 2	SCS-X8	SCS-X7	SCS-X6	SCS-X5	SCS-X4	SCS-X3	SCS-X2	SCS-X1
Byte 3	0	0	0	0	0	0	0	0
Byte 4	CE-X8B	CE-X8A	CE-X7B	CE-X7A	CE-X6A	CE-X6A	CE-X5B	CE-X5A

Table 35: Bit content of diagnostic register

Key

- **MI-LVS**: Module information byte – voltage for system/sensor power supply low
- **MI-LVA**: Module information byte – voltage for actuator low
- **MI-SCS**: Module information byte – sensor short-circuit at an M12 slot
- **MI-SCA**: Module information byte – actuator short-circuit
- **MI-FC**: Module information byte – forcing active
- **MI-IME**: Module information byte – internal module error
- **CE-X5A...CE-X8A**: Channel error,
  channel A (contact pin 4) of slots X5 to X8
- **CE-X5B...CE-X8B**: Channel error,
  channel B (contact pin 2) of slots X5 to X8

The PDO's 0x1600 or 0x1601 can be selected for the output data of the module.

PDO 0x1600, Output data in byte format

PDO		PDO Content			
Index	Size	Index	Size	Type	Name
0x1600	2	0x6200:01	1.0	USINT	Port X5A..X8B (see table 37)

Table 36: Input data in byte format

Content of Port X5A..X8B:

Index	Bit 7	Bit 6	Bit5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0x6200:01	X8B	X8A	X7B	X7A	X6B	X6A	X5B	X5A

Table 37: Bit assignment for input data in byte format

- X5A...X8A: Output data, channel A (contact pin 4) of slots X5 to X8
- X5B...X8B: Output data, channel B (contact pin 2) of slots X5 to X8

PDO 0x1601, Output data in bit format

PDO		PDO Content			
Index	Size	Index	Size	Type	Name
0x1601	2	0x6220:01	0.1	BIT	Port X5A
		0x6220:02	0.1	BIT	Port X5B
		0x6220:03	0.1	BIT	Port X6A
		0x6220:04	0.1	BIT	Port X6B
		0x6220:05	0.1	BIT	Port X7A
		0x6220:06	0.1	BIT	Port X7B
		0x6220:07	0.1	BIT	Port X8A
		0x6220:08	0.1	BIT	Port X8B

Table 38: Input data in bit format

5.4.5 Device parameter

The module variants (16DI, 16DO or 8DI/8DO) support different parameter. The parameters will be transferred in the startup from the controller to the device. The following blocks of parameter can be adjusted:

General device settings

Index (Bit)	Parameter
0x2300:01	Web interface locked: 0 = false, 1 = true
0x2300:02	Force mode locked: 0 = false, 1= true
0x2300:03	Disable all emergency messages: 0 = false, 1 = true
0x2300:04	Disable UL emergency messages: 0 = false, 1 = true (DO variants only)
0x2300:05	Disable actuator emergency messages: 0 = false, 1 = true (DO variants only)
0x2300:06	DCU Startup: 0 = locked, 1 = disabled, 2 = run (8DI/8DO DCU1 only)

Table 39: Possible parameter options for the general device settings

Surveillance timeout

The firmware of the modules allows you to define a delay time before the monitoring of the output currents begins, known as the surveillance timeout. You can define this for every individual output channel.

The delay time begins after the status of the output channel changes, i.e. when this is activated (after a rising edge) or deactivated (after a falling edge). After this time has elapsed, the monitoring of the output begins and the diagnosis reports error states.

The value of the surveillance timeout is 0 to 255 ms. The standard value is 80 ms. When the output channel is in the static state, i.e. the channel is permanently switched on or off, the value is 100 ms.

Index (Bit)	Parameter
0x2301:01	Surveillance timeout port X1, channel A (pin 4), possible values 0…255
0x2301:02	Surveillance timeout port X1, channel B (pin 2), possible values 0…255
0x2301:15	Surveillance timeout port X8, channel A (pin 4), possible values 0…255
0x2301:16	Surveillance timeout port X8, channel B (pin 2), possible values 0…255

Table 40: Possible surveillance timeout values for module 16DO

Index (Bit)	Parameter
0x2301:01	Surveillance timeout port X5, channel A (pin 4), possible values 0…255
0x2301:02	Surveillance timeout port X5, channel B (pin 2), possible values 0…255
0x2301:07	Surveillance timeout port X8, channel A (pin 4), possible values 0…255
0x2301:08	Surveillance timeout port X8, channel B (pin 2), possible values 0…255

Table 41: Possible surveillance timeout values for module 8DI/8DO

Failsafe function

The firmware of the modules provides a fail-safe function for the outputs. During the configuration of the modules, you have the option to define the status of the outputs after an interruption or a loss of communication.

The following options are available:

- **Set low**: Deactivates the output channel (value = 0)
- **Set high**: Activates the output channel (value = 1)
- **Hold last**: Holds the last output status (value = 2)

Index (Bit)	Parameter
0x2302:01	Failsafe port X1, channel A (pin 4), possible values: 0…2
0x2302:02	Failsafe port X1, channel B (pin 2), possible values: 0…2
0x2302:15	Failsafe port X8, channel A (pin 4), possible values: 0…2
0x2302:16	Failsafe port X8, channel B (pin 2), possible values: 0…2

Table 42: Possible failsafe values with module 16DO

Index (Bit)	Parameter
0x2302:01	Failsafe port X5, channel A (pin 4), possible values: 0…2
0x2302:02	Failsafe port X5, channel B (pin 2), possible values: 0…2
0x2302:07	Failsafe port X8, channel A (pin 4), possible values: 0…2
0x2302:08	Failsafe port X8, channel B (pin 2), possible values: 0…2

Table 43: Possible failsafe values for module 8DI/8DO

5.4.6 Configuration example with TwinCAT® 3

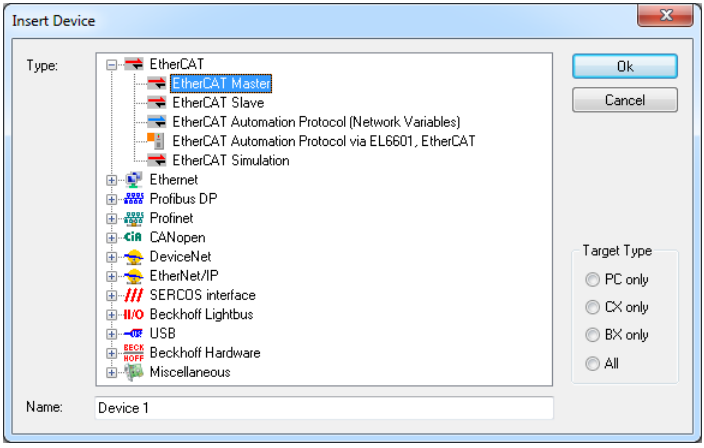
The configuration and start-up of the modules described on the following pages refers to the TwinCAT® 3 software from Beckhoff Automation GmbH. If you are using a control system from another provider, please consider the related documentation.

☐ Install the ESI file of the module family in TwinCat®. For TwinCat® the ESI file normally has to be copied to the installation folder, e.g.: `C:\TwinCAT\3.1\Config\Io\EtherCAT`.

After the installation (TwinCAT® needs a restart), the modules are available in the hardware catalog.

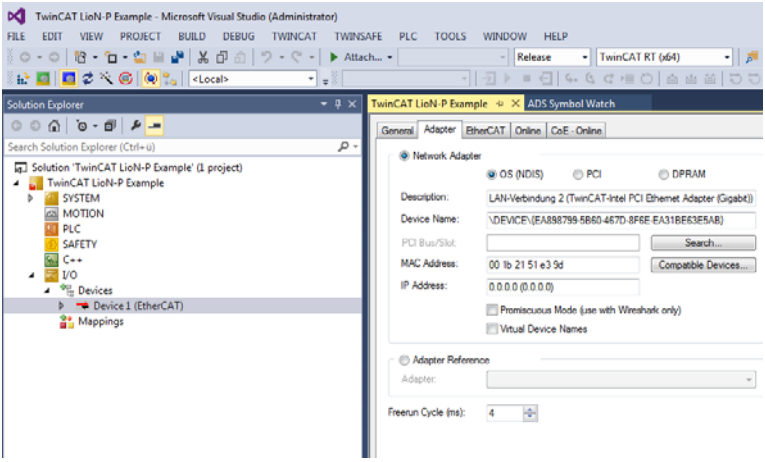
☐ Start TwinCat and open a new project.

☐ Change to the "I/O" option in the Solution Explorer in the left workspace window. With a right mouse click on a device choose the option: “Add New Item …”. Then choose “EtherCAT Master”.



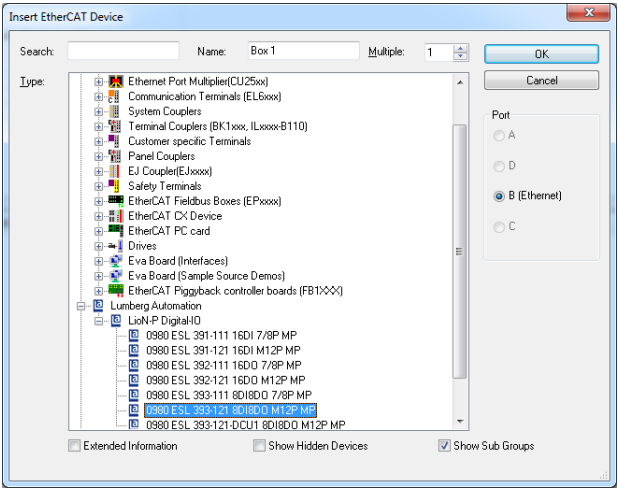
☐ If not already done, choose the network adapter and install the driver for EtherCAT real time communication.

☐ Click “Adapter” followed by “Compatible Devices…” for choosing the driver and installation of the EtherCAT driver.



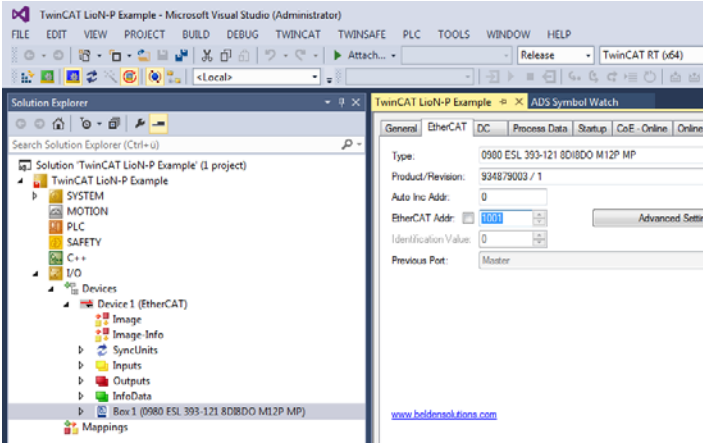
☐ Select the I/O device from the hardware catalog.

Change to the "I/O" option in the Solution Explorer in the left workspace window. With a right mouse click on the EtherCAT master (Device 1) choose the option “Add New Item …”. Select the device and click OK.



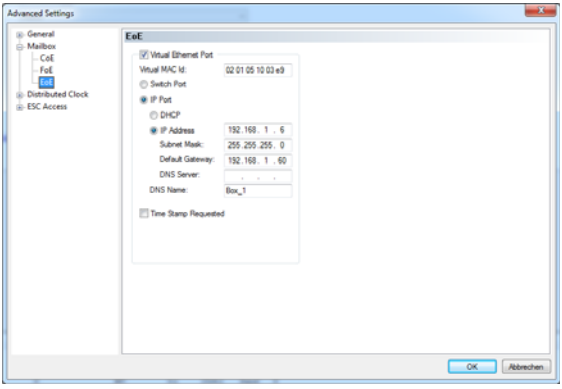
☐ Set the IP address for EoE protocol.

For using the web interface of the devices the IP-address must be set. Click “Advanced Settings…” in the EtherCAT Tab. Navigate to “Mailbox” and “EoE”.



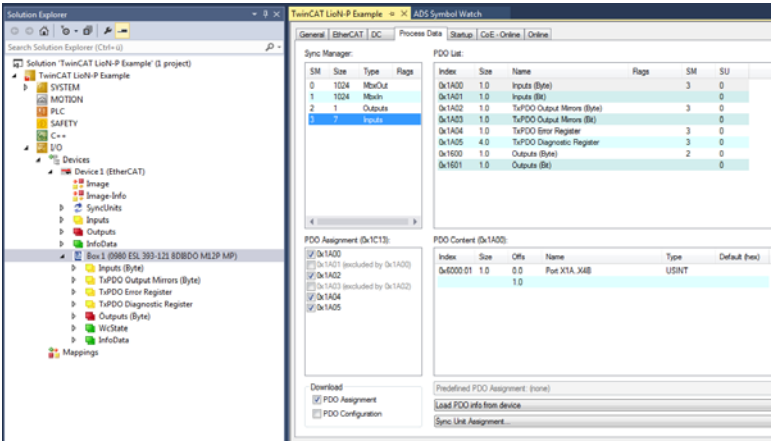
☐ Disable “Virtual Ethernet Port” if no web services should be used.

☐ Click “IP Port” and and “IP Address” when web services will be used. Enter your IP-settings depending from your local network adapter settings.

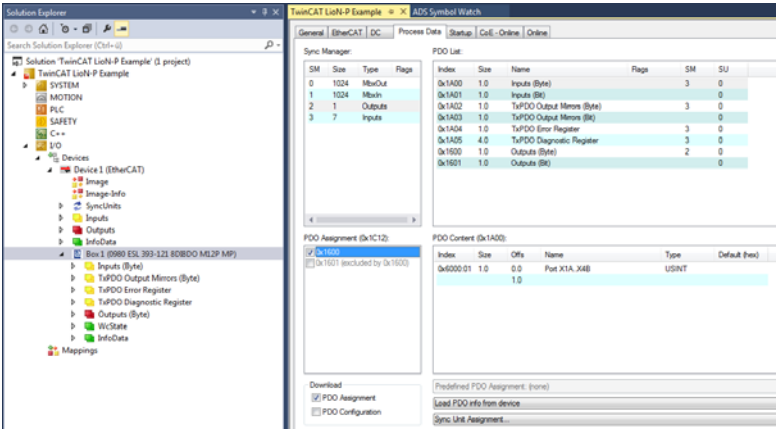


☐ Change to the “Process Data” tab and choose your Inputs and Outputs PDO’s as described in chapter “PDO’s for 16DI modules: 0980 ESL 391-xxx” on page 24 to “8DI/8DO modules: 0980 ESL 393-xxx” on page 30.

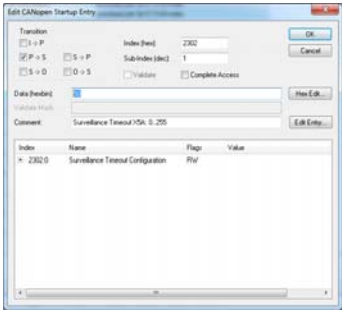
☐ Click “Inputs” and choose your PDO’s in the PDO Assignment box.



☐ Click “Outputs” and choose your PDO’s in the PDO Assignment box.



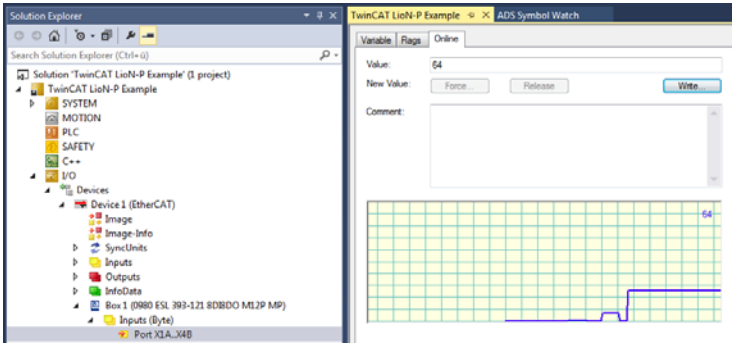
☐ Change to the “Startup” folder and check the default device parameter settings. With a double click on a parameter the "edit" dialogbox opens. The new value can be entered into the "data" dialogbox:

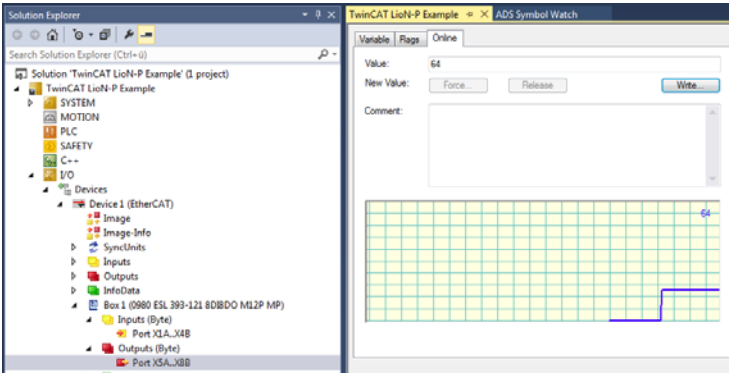


☐ When the device is connected to the EtherCAT network click the “TWINCAT” tab and choose “Activate Configuration”.

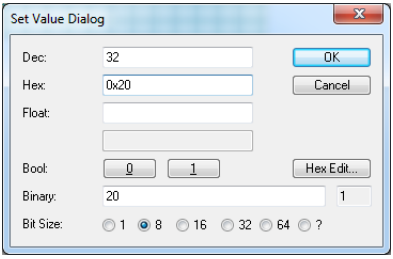
⚠ **WARNING**
Before you set the inputs or outputs of the module, be aware that no personal injury or damage to equipment can be happen.

☐ Click the “TWINCAT” tab again and choose “Restart TwinCAT (Config Mode)”. Confirm your selection by clicking “Yes”. The device will now change into the “OP” state and will transfer I/O data.





☐ Click the “Write…” Button for setting an output of the device. The following dialogbox will appear:



6 The integrated web server

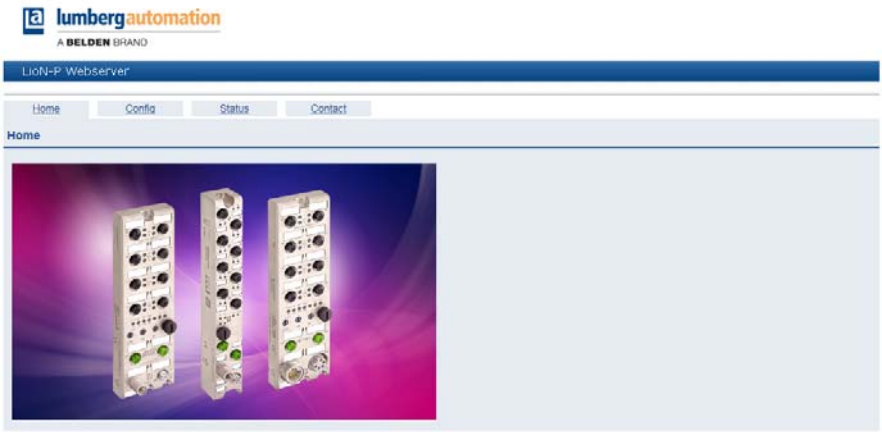
The modules provide an integrated web server for configuration, monitoring, and diagnosis. You have the option to call up the internal stored websites by entering the address in a web browser. To do this, replace the placeholder `[IP address]` with the IP address of the relevant module.

For using the integrated web server in an EtherCAT environment, the EoE protocol must be configured for controller and field module.

6.1 The Home page

The address of the Home page is:

`http://[IP address]/home.htm`



This page is the starting point for accessing the integrated web server.

6.2 The Configuration page (Config)

The address of the configuration page is:

`http://[IP address]/config.htm`

On this page you have the option to access the following values and parameters:

- Restore Factory Settings:
  - The module restores the factory settings
- Firmware Update:
  - The firmware of the device can be updated with this function.

    For further information see chapter “Firmware update” on page 54.

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

6.3 The Status page

The address of the Status page is:

`http://[IP address]/status.htm`

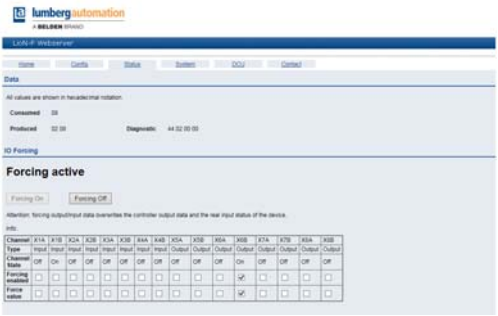
On this page you have the option to read the following values:

- **Process data**:
  - Output data ("Consumed")
  - Input data ("Produced") with output status
- **Diagnostic data**:
  - Module information byte and channel diagnostic bytes, for data description see “PDO 0x1A04, Diagnostic register” on page 26

You can also control

- **Forcing**:
  - This module is for testing purposes. The input and output data can be set from this web page as well as overruling the physical input data and the logical output data from the controller. For safety reasons this mode can be disabled by parametrization.

⚠ **WARNING**
Using of the force mode can result in serious personal injury or damage to equipment. Be careful when using the force mode.



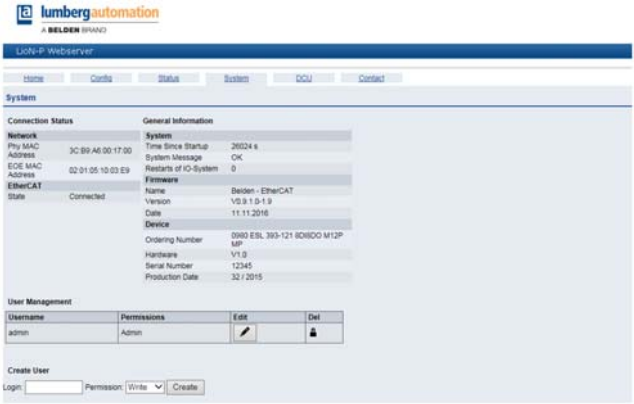
6.4 The System page

The address of the Status page is:

`http://[IP address]/system.htm`

This page delivers the following data and options:

- **Network MAC address**
- **Network state**
- **System status**:
  - System runtime
  - System information
  - Number of restarts of the I/O-system
- **Firmware version and date**
- **Device information**:
  - Ordering number
  - Serial number
  - Production year and week
- **User management**:
  - Creating, changing or deleting of user or user settings



6.5 The DCU page

The address of the contact page is:

http://[IP address]/contact.htm

This page is only available for the device 0980 ESL 393-121-DCU1.

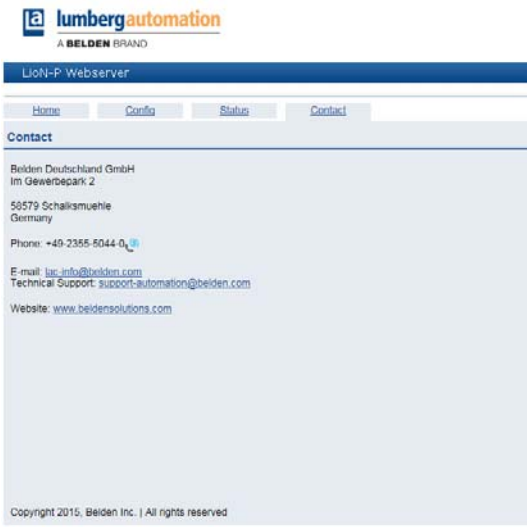
This page provides status and control information for distributed control unit of the device. For detailed information of the DCU function see the manual **Manual_LioN_P_DCU1_EN.pdf**

6.6 The Contact page

The address of the contact page is:

`http://[IP address]/contact.htm`

This page provides information on the contact data for Belden Deutschland GmbH.



7 Diagnostics processing

The modules provide advanced diagnosis behavior, especially for the output channels. The firmware of the modules distinguish between 5 different types of error.

7.1 Output channel error

A channel error is determined by comparing the target value set by a controller and the actual value of an output channel.

Target value	Actual value	Comment
Active	Active	OK, no diagnosis
Off	Off	OK, no diagnosis
Active	Off	Short-circuit Channel indicator is red Channel error bit in the diagnosis is set Channel is locked after the error is rectified.
Off	Active	Voltage is fed back in Red and yellow/white channel indicators are activated Channel error bit in the diagnosis is set Channel is not locked after the error is rectified

Table 44: Interpretation of channel errors

NOTE

If both output channels of an M12 slot are activated when a channel error occurs, the controller locks both channels, even if only one channel is affected by the error. If only one channel is activated, the controller only locks this one. Locked channels are deactivated and remain in the Off state if you do not reset them using the controller.

When an output channel is activated (rising edge of the channel state) or deactivated (falling edge), the channel errors are filtered for the period that you set using the "Surveillance-Timeout" parameter during the configuration of the module. The value of this parameter can range from 0 to 255 ms; the factory setting is 80 ms.

The filter is used to avoid premature error messages when a capacitive load is activated or an inductive load is deactivated, and during other voltage peaks when a status changes.

When a channel is in the static state (permanently activated or deactivated) the controller uses a fixed specified duration of 100 ms for filtering the error message.

7.2 Voltage error at the M12 slots (sensor short- circuit)

At every M12 input socket of the modules, pin 1 supplies a monitored sensor voltage U_S.

In case of a sensor short-circuit, a voltage error is reported. Both channel indicators of the M12 input socket light up red, and the relevant error bit for the sensor short-circuit is set in the diagnosis bytes.

7.3 Overload of output drivers

The output drivers of the modules with output functions (variants 16DO and 8DI/8DO) report an error when they detect an overload. This error is reported by setting the relevant channel error bits in the diagnosis bytes.

NOTE
If both output channels of an M12 slot are activated when a channel error occurs, the controller locks both channels, even if only one channel is affected by the error. If only one channel is activated, the controller only locks this one. Locked channels are deactivated and remain in the Off state if you do not reset them using the controller.

If there is an overload, the status indicator of the active output channel lights up red. If both output channels of an M12 slot are active during an overload, both status indicators light up red.

The error message is filtered by the "Surveillance-Timeout" parameter.

7.4 Error in the actuator power supply

The voltage value at the connections for the power supply of the actuators is monitored globally and on the module level.

If the actuator power supply U_L is beyond the voltage range of 18,6 V up to 30 V, an error is reported. The U_L indicator lights up red and the actuator under voltage bit is set in the module information byte.

When output channels are activated, the voltage error is also displayed by setting the relevant error bits of the M12 slots.

NOTE

Every output channel that is active at the same time as the error occurs in supply voltage U_L is locked. This means that for correct operation, the output channel must be reset by the controller when the status of the supply voltage U_L is normalized again.

We recommend deactivating all output channels with the controller as soon as the undervoltage is detected. Otherwise, because it is locked, every active output channel will report a diagnosis when the voltage value is normalized again.

The error message is filtered by means of a fixed filter period of 300 ms.

7.5 Error in the system/sensor power supply

The voltage value for the system/sensor power supply is also monitored globally. If the value is beyond the voltage range of 18.6 to 30 V, an error message is created.

The U_S indicator lights up red and the sensor under voltage bit is set in the module information byte.

The error message has no effect on the outputs and is not filtered, but is reported immediately.

⚠ CAUTION
It must definitely be ensured that the supply voltage, measured at the most remote participant is not below 18,6 V DC from the perspective of the system power supply.

8 Emergency messages

When parametrized, the device sends emergency messages to the master in case of detected diagnosis. The coding of the first and the second part of the emergency messages are leaned to the CiA 301 and CiA 401 specifications. The third part of the emergency message is the known (manufacturer defined) diagnostic register.

The emergency message has a format of 8 bytes and is coded as follows:

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
Emergency error code		Error register CoE 0x1001	Diagnostic register				

Table 45: Byte content of the emergency message

Content of the error register (CoE register 0x1001):

Emergency error code Byte 1, Byte 2	Error register (CoE 0x1001, Byte 3							
	B7	B6	B5	B4	B3	B1	B0	Error description (Bit 7 - Bit 0)
0x0000	0	0	0	0	0	0	0	No error
0x2300	0	0	0	0	0	1	1	Output overload error, MI-SCS or MI-SCA
0x3100	0	0	0	0	1	0	1	Voltage error, MI-LVS
0x3300	0	0	0	0	1	0	1	Voltage error outputs, MI-LVA
0xF000	1	0	0	0	0	0	1	Additional function forcing, MI-FC
0xFF00	1	0	0	0	0	0	1	Additional function device diagn., MI-IME

Table 46: Content of error register

Content of the diagnostic register (depends on module 16DI, 16DO or 8DI/8DO):

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 4	MI-IME	MI-FC	0	0	MI-SCA	MI-SCS	MI-LVA	MI-LVS
Byte 5	SCS-X8	SCS-X7	SCS-X6	SCS-X5	SCS-X4	SCS-X3	SCS-X2	SCS-X1
Byte 6	CE-X4B	CE-X4A	CE-X2B	CE-X2A	CE-X2A	CE-X2A	CE-X1B	CE-X1A
Byte 7	CE-X8B	CE-X8A	CE-X7B	CE-X7A	CE-X6A	CE-X6A	CE-X5B	CE-X5A
Byte 8	0	0	0	0	0	0	0	0

Table 47: Content of diagnostic register

Key

- **MI-LVS**: Module information byte – voltage for system/sensor power supply low
- **MI-LVA**: Module information byte – voltage for actuator low
- **MI-SCS**: Module information byte – sensor short-circuit at a M12 slot
- **MI-SCA**: Module information byte – actuator short-circuit
- **MI-FC**: Module information byte – forcing active
- **MI-IME**: Module information byte – internal module error
- **CE-X1A...CE-X8A**: Channel error,
  channel A (contact pin 4) of slots X1 to X8
- **CE-X1B...CE-X8B**: Channel error,
  channel B (contact pin 2) of slots X1 to X8

The following example shows the emergency message received by the TwinCAT master for an actuator voltage supply fault.

3 21.11.2016 16:16:41 390 ms | 'Box 1 (0980 ESL 393-121 8D' (1001): CoE - Emergency (Hex: 3300, 05, '02 00 00 00 00').

9 Firmware update

A firmware update of the module can be done with the modules' integrated web server over the EoE (Ethernet over EtherCAT) protocol, or over the FoE protocol (File over EtherCAT).

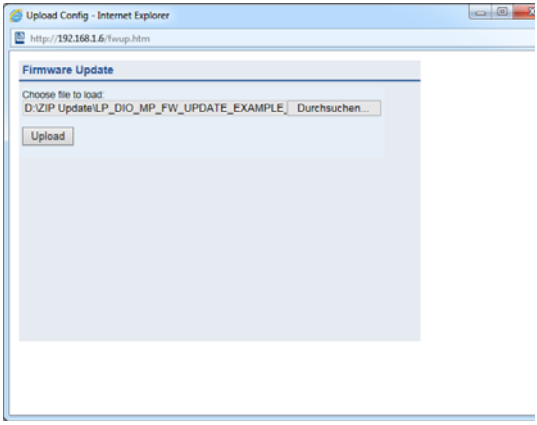
⚠ WARNING
Don’t disconnect the power supply of the device during the update!

9.1 Firmware update with EoE

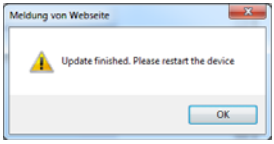
The EoE service must be supported by the master and the device. For configuring the EoE service on a device see chapter “Configuration example with TwinCAT® 3” on page 37.

If the EoE service is configured and the device is at least in the Pre-Op state, enter the IP address of the device into your browser and navigate to the “Config” page.

Click the button “Firmware Update” and select the update file provided by Belden.



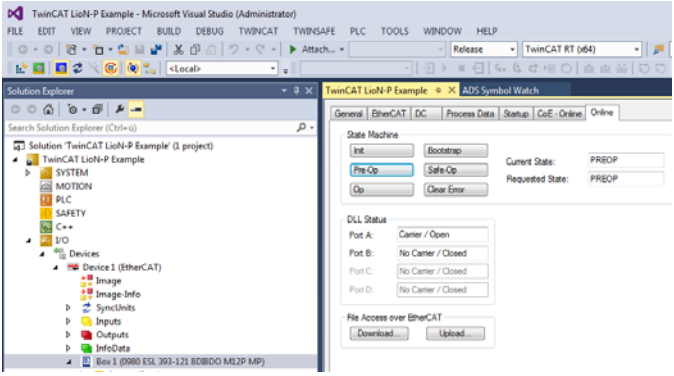
Click "Upload" and wait for the message to restart your device.



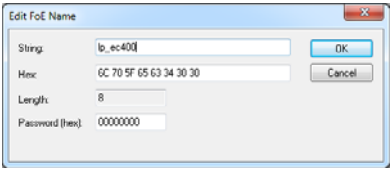
With the next restart your device will start up with the new firmware.

9.2 Firmware update with FoE

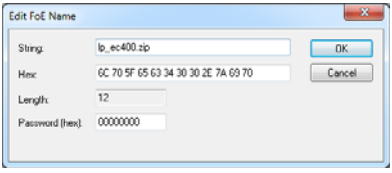
The FoE service must be supported by the master and by the device. Per default the FoE service is supported by the device. If the FoE service is configured and the device is at least in the Pre-Op state, follow the example for TwinCAT:



Click the “Download” button in section “File Access over EtherCAT” and select the update file provided by Belden:



Add the file extension “.zip” in the string field if not visible.



Click “OK” and wait until the file is transferred into the device.

After the file is transferred, a reset command or power cycle is needed. With the restart of the device the update package will be extracted and the old firmware files will be replaced by the new files included within the update package.

The LED left of the U_S LED (U_L LED for devices with outputs) is flickering and blinking red during the update.

After all files have been extracted, the U_L and U_S LED are blinking green two times. Afterwards the device does a restart and the firmware update is finished.

10 Technical data

10.1 General

Protection class	IP65 IP67 IP69K (not for 7/8") (only when the connectors are screwed in or when protective caps are used; not under UL investigation)
Ambient temperature	-40 °C to +70 °C (-40 °F to +158 °F)
Weight	480 g
Housing material	Die-cast zinc
Vibration resistance (oscillation)	15 g / 5–500 Hz
Shock resistance	50 g / 11 ms
Torques: M4 fixing screws M4 ground connection M12 connector	 1.0 Nm 1.0 Nm 0.5 Nm

Table 48: General information

10.2 Bus system

Protocol	EtherCAT® (ETG.1000 V1.2)
ESI file	LumbergAutomation-LioN-P-Digital-IO.xml
Data transmission rate	100 Mbit/s, full duplex
Transmission procedure Autonegotiation	100BASE-TX is supported
Type of addressing	Auto-increment addressing, Fixed addressing
Min. Cycle Time	250µs
Mailbox Protocol	CanOpen over EtherCAT (CoE) File access over EtherCAT (FoE), Ethernet over EtherCAT (EoE)

Table 49: Information about the bus system

Product code	0x37b92ad1 (934882001, 0980 ESL 391-111 16DI 7/8P) 0x37b92ad2 (934882002, 0980 ESL 392-111 16DO 7/8P) 0x37b92ad3 (934882003, 0980 ESL 393-111 8DI8DO 7/8P) 0x37b91f19 (934879001 0980 ESL 391-121 16DI M12P) 0x37b91f1a (934879002 0980 ESL 392-121 16DO M12P) 0x37b91f1b (934879003 0980 ESL 393-121 8DI8DO M12P) 0x37b91f1d (934879007 0980 ESL 393-121-DCU1 8DI8DO M12P)
Supported Ethernet protocols	Ping HTTP TCP/IP
Switch functions	Integrated
EtherCAT interface Port Autocrossing	2 M12 sockets 4-pin, D-coded (see pin assignment) is supported

Table 49: Information about the bus system

10.3 Power supply for the module electronics/sensors

Nominal voltage U_S	24 V DC (SELV/PELV)
Voltage range	18-30 V DC
Power consumption of module electronics	Typically 95 mA
Voltage level of the sensor power supply	Min. (U_S – 1.5 V)
Current consumption of sensors	Max. 200 mA (at T_U = 30 °C) per Port
Reverse polarity protection	Yes
Operational indicator (U_S)	LED green, 18,6 V <= U_S <= 30 V LED red, U_S < 18,6 V or U_S > 30 V

Table 50: Information about the power supply for the module electronics/sensors

10.4 Power supply for the actuators

Nominal voltage U_L	24 V DC (SELV/PELV)
Voltage range	18-30 V DC
Electric isolation	Yes
Threshold value of the undervoltage detection	Typ. 18 V
Delay time of the undervoltage detection	< 20 ms
Reverse polarity protection	Yes
Operational indicator (U_L)	LED green, 18,6 V <= U_L<= 30 V LED red, U_L < 18,6 V or U_L> 30 V

Table 51: Information about the power supply for the actuators

10.5 Inputs

Input connection	Type 3 as per IEC 61131-2
Nominal input voltage	24 V DC
Input current at 24 V DC	Typically 5 mA
Short-circuit protection	Yes
Channel type	Normally open, p-switching
Number of digital channels	16 with 16DI 0 with 16DO 8 with 8DI/8DO
Status indicator	LED yellow for channel A, LED white for channel B
Diagnosis indicator	LED red for each slot
Port	M12 socket, 5-pin See pin assignment

Table 52: Input information

10.6 Outputs

Output connection	Typically 2 A as per IEC 61131-2
Nominal output current per channel: Signal status “1” Signal status “0”	2 A, see Info 1 max. 2 A Max. 1 mA (according to specification)

Table 53: Output information

Signal level of the outputs: Signal status “1” Signal status “0”	Min. (V_L – 1 V) max. 2 V
Short-circuit protection	Yes
Max. output current per module	7/8P: As per U_L approval: 9 A (12 A see Info 2) M12P: 16 A
Overload protection	Yes
Number of digital channels	0 with 16 DI 16 with 16DO 8 with 8DI/8DO
Channel type	Normally open, p-switching
Status indicator	LED yellow per channel A, LED white per channel B
Diagnosis indicator	LED red per channel
Port	M12 socket, 5-pin See pin assignment

Info 1: With inductive loads of consumption category DC13 (EN60947-5-1), the outputs can connect currents of 1.6 A at a frequency of 1 Hz (not under UL investigation)

Info 2: Technically possible and approved under the following conditions (not under UL investigation):
- Looped sensor/system power supply max. 2.5 A
- Power supply cable STL 204 (5 x 1.0 mm²)
- Ambient temperature max. 40 °C

Table 53: Output information

10.7 LEDs

U_S	Green	System/sensor power supply, voltage level 18,6 V <= U_S <=30 V
	Red	System/sensor power supply, voltage level U_S < 18,6 V or U_S > 30 V
	Off	No system/sensor power supply
U_L	Green	Actuator power supply, voltage level 18,6 V <= U_L <= 30 V
	Red	Actuator power supply, voltage level U_L< 18,6 V or U_L > 30 V
	Off	No actuator power supply

Table 54: Information about the LED colors

X1…X8 A/DIA	Yellow	Channel status A “On”
	Red	Periphery error (sensor or actuator overload/short-circuit)
	Off	Not connected, status “Off”, no error
X1…X8 B	White	Channel status B “On”
	Red	Periphery error (actuator overload/short-circuit)
	Off	Not connected, status “Off”, no error
X01 Link/Act X02 Link/Act	Green	Ethernet connection exists to another subscriber. Link connection created
	Flashing yellow	Data exchange with another subscriber
	Off	No connection to another subscriber. No link, no data exchange
RUN	Green	The device is in state OPERATIONAL
	Single flash	The device is state SAFE-OERATIONAL
	Red	Serious error that cannot be resolved
	Blinking	The device is in state PRE-OPERATIONAL
	Alternately flashing red/green	The device is performing a self-test
	Off	The device is in state INIT
	Flickering	The device is booting and has not entered the INIT state. Or the device is in state BOOTSTRAP
ERR	Red	Application controller failure. E.g. PDI watchdog timeout
	Flickering	Booting error
	Blinking	Invalid configuration, general configuration error
	Single Flash	Local error / unsolicited state change
	Double Flash	Watchdog error
	Off	No error

Table 54: Information about the LED colors

11 Accessories

Item number	Description
0985 706 100/… M	Connection cable for EtherNet, with M12 connector at both ends, straight, 4-pin, D-coded, 24AWG TPE with blue-green casing, highly flexible, multi-wire/unshielded, 2 twisted wire pairs.
0985 706 101/… M	Connection cable for EtherNet, crossover, with M12 connector at both ends, straight, 4-pin, D-coded, 24AWG TPE with blue-green casing, highly flexible, multi-wire/unshielded, 2 twisted wire pairs.
0985 706 103/… M	Connection cable for EtherNet, with M12 connector at both ends, straight, 4-pin, D-coded and RJ45 connector, 24AWG TPE with blue-green casing, highly flexible, multi-wire/unshielded, 2 twisted wire pairs.
0985 707 100/… M	Connection cable for EtherNet, with M12 connector at both ends, straight, 4-pin, D-coded, 24AWG PVC with blue-green casing, flexible, solid conductor/unshielded, 2 twisted wire pairs.
0985 707 101/… M	Connection cable for EtherNet, crossover, with M12 connector at both ends, straight, 4-pin, D-coded, 24AWG PVC with blue-green casing, flexible, solid conductor/unshielded, 2 twisted wire pairs.
0985 S4549 100/… M	Connection cable for EtherNet, with M12 connector at both ends, straight, 4-pin, D-coded, 26AWG PUR, halogen-free, with water-blue casing, multi-wire/shielded, 2 twisted wire pairs.
0985 S4549 103/… M	Connection cable for EtherNet, with M12 connector at both ends, straight, 4-pin, D-coded and RJ45 connector, 26AWG PUR, halogen-free, with water-blue casing, multi-wire/shielded, 2 twisted wire pairs.

Table 55: Connection cables for data transfer

Item number	Description
0986 EMC 102	M12 cable connector for EtherNet cable, straight, 4-pin, D-coded, connection for spring terminal

Table 56: Customizable connectors for data transfer

Item number	Description
RK 40-637/… F RS 40-637/… F	MINI, 7/8" connection cable, one end with cable plug (RS) or socket (RK), straight, 4-pin, 18AWG TPE, conductor IEC color-coded
RK 40-602/… M RS 40-602/… M	MINI, 7/8" connection cable, one end with cable plug (RS) or socket (RK), straight, 4-pin, 18AWG PUR, conductor IEC color-coded
RK 40-739/… F	MINI, 7/8" connection cable, one end with cable socket, straight, 4-pin, 18AWG TPE, conductor US color-coded
RKW 40-637/… F RSW 40-637/… F	MINI, 7/8" connection cable, one end with cable plug (RS) or socket (RK), angled, 4-pin, 18AWG TPE, conductor IEC color-coded
RKW 40-602/… M RSW 40-602/… M	MINI, 7/8" connection cable, one end with cable plug (RS) or socket (RK), angled, 4-pin, 18AWG PUR, conductor IEC color-coded

Table 57: Connection cables for the power supply

Item number	Description
RKW 40-739/… F	MINI, 7/8" connection cable, one end with cable socket, angled, 4-pin, 18AWG TPE, conductor US color-coded
RSRK 40-637/… F	MINI, 7/8" connection cable, both ends with cable plug (RS) and socket (RK), straight, 4-pin, 18AWG TPE, conductor IEC color-coded
RSRK 40-602/… M	MINI, 7/8" connection cable, both ends with cable plug (RS) and socket (RK), straight, 4-pin, 18AWG PUR, conductor IEC color-coded
RSRKW 40-637/… F	MINI, 7/8" connection cable, both ends with cable plug (RS), straight, and socket (RK), angled, 4-pin, 18AWG TPE, conductor IEC color-coded
RSRKW 40-602/… M	MINI, 7/8" connection cable, both ends with cable plug (RS), straight, and socket (RK), angled, 4-pin, 18AWG TPE, conductor IEC color-coded

Table 57: Connection cables for the power supply

Item number	Description
RSC 40/9 RSC 40/11 RSC 40/16	MINI, 7/8" cable plug, 4-pin, connection via screw terminal, /9 for cable diameter 6 to 8 mm, /11 for 8 to 10 mm, /16 for 12 to 14 mm
RKC 40/9 RKC 40/11 RKC 40/16	MINI, 7/8" cable socket, 4-pin, connection via screw terminal, /9 for cable diameter 6 to 8 mm, /11 for 8 to 10 mm, /16 for 12 to 14 mm
RK 50-637/… F RS 50-637/… F	MINI, 7/8" connection cable, one end with cable plug (RS) or socket (RK), straight, 5-pin, 18AWG TPE, conductor IEC color-coded
RK 50-602/… M RS 50-602/… M	MINI, 7/8" connection cable, one end with cable plug (RS) or socket (RK), straight, 5-pin, 18AWG PUR, conductor IEC color-coded
RK 50-739/… F	MINI, 7/8" connection cable, one end with cable socket, straight, 5-pin, 18AWG TPE, conductor US color-coded

Table 58: Customizable connectors for the power supply

Item number	Description
RKV	Cover for unused MINI, 7/8" device sockets
RSV	Cover for unused MINI, 7/8" device plugs

Table 59: Other accessories