



## Documentation

# CX8190

## Embedded PC for Ethernet

**Version:** 1.1  
**Date:** 2019-04-15

**BECKHOFF**



# Table of contents

<b>1</b>	<b>Notes on the documentation</b>	<b>5</b>
1.1	Explanation of symbols	6
1.2	Documentation Issue Status	7
<b>2</b>	<b>For your safety</b>	<b>8</b>
2.1	Intended use	8
2.2	Staff qualification	8
2.3	Safety instructions	9
<b>3</b>	<b>Transport and storage</b>	<b>10</b>
<b>4</b>	<b>Product overview</b>	<b>11</b>
4.1	Structure	12
4.2	Name plate	13
4.3	Ethernet interfaces	14
4.4	MicroSD card	17
4.5	Reset button	17
<b>5</b>	<b>Commissioning</b>	<b>18</b>
5.1	Mounting	18
5.1.1	Dimensions	18
5.1.2	Note the permissible installation positions	19
5.1.3	Securing on mounting rail	21
5.2	Connecting the power supply	22
<b>6</b>	<b>Configuration</b>	<b>24</b>
6.1	Operating system	24
6.1.1	Features included	25
6.1.2	Update image	26
6.2	IP address	27
6.2.1	Setting with DIP switches	27
6.2.2	Setting in the operating system	28
6.3	Web service	29
6.3.1	Starting the Beckhoff Device Manager	29
6.3.2	Changing the IP address of the Ethernet interfaces (X101, X102)	30
6.3.3	Enabling a remote display	31
6.3.4	Starting a remote connection	32
6.4	TwinCAT	33
6.4.1	Connecting to the CX81xx	33
6.4.2	Scanning for devices	35
6.4.3	Creating a PLC project	36
6.4.4	Linking variables	38
6.4.5	Configuring Realtime Ethernet	39
6.4.6	Configuring the EtherCAT Automation Protocol (EAP)	41
<b>7</b>	<b>Programming</b>	<b>43</b>
7.1	Seconds UPS	43
7.1.1	Function block	45
7.1.2	Data types	47

7.1.3	PlcAppSystemInfo .....	48
7.2	Control diagnostic LEDs .....	49
7.2.1	Function F_CX81x0_LED_WD .....	49
7.2.2	Function F_CX81x0_LED_ERR .....	49
7.2.3	Data type E_CX81x0_LED .....	50
7.3	Function F_CX81xx_ADDRESS .....	50
7.4	Real Time Clock (RTC).....	50
<b>8</b>	<b>Ethernet X001 Interface.....</b>	<b>51</b>
8.1	Ethernet .....	51
8.2	Topology example .....	53
8.3	ADS-Communication .....	54
<b>9</b>	<b>Error handling and diagnosis.....</b>	<b>56</b>
9.1	Diagnostic LEDs .....	56
9.2	Power supply terminal LEDs in K-bus mode .....	56
9.3	Power supply terminal LEDs in E-bus mode .....	59
<b>10</b>	<b>Care and maintenance .....</b>	<b>60</b>
10.1	Replace the battery .....	60
<b>11</b>	<b>Technical data.....</b>	<b>61</b>
<b>12</b>	<b>Appendix .....</b>	<b>63</b>
12.1	Certification.....	63
12.1.1	FCC .....	63
12.2	Support and Service .....	64



# 1 Notes on the documentation

This description is only intended for the use of trained specialists in control and automation engineering who are familiar with the applicable national standards.

It is essential that the documentation and the following notes and explanations are followed when installing and commissioning the components.

It is the duty of the technical personnel to use the documentation published at the respective time of each installation and commissioning.

The responsible staff must ensure that the application or use of the products described satisfy all the requirements for safety, including all the relevant laws, regulations, guidelines and standards.

## Disclaimer

The documentation has been prepared with care. The products described are, however, constantly under development.

We reserve the right to revise and change the documentation at any time and without prior announcement.

No claims for the modification of products that have already been supplied may be made on the basis of the data, diagrams and descriptions in this documentation.

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## Patent Pending

The EtherCAT Technology is covered, including but not limited to the following patent applications and patents:

EP1590927, EP1789857, DE102004044764, DE102007017835

with corresponding applications or registrations in various other countries.

The TwinCAT Technology is covered, including but not limited to the following patent applications and patents:

EP0851348, US6167425 with corresponding applications or registrations in various other countries.



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## 1.1 Explanation of symbols

The following symbols with corresponding warnings or explanatory text are used in the documentation. Read and follow the warnings.

### Symbols that warn of personal injury:

#### **DANGER**

##### **Serious risk of injury**

Note this warning. Hazard with high risk of death or serious injury.

#### **WARNING**

##### **Risk of injury**

Note this warning. Hazard with medium risk of death or serious injury.

#### **CAUTION**

##### **Personal injuries**

Note this warning. Hazard with a low degree of risk, which could lead to minor or moderate injury.

### Symbols that warn of damage to property or equipment:

#### **NOTE**

##### **Damage to the devices or environment**

Note this warning. Risk of damage to the environment and equipment.

### Symbols indicating further information or tips:



#### **Tip or pointer**

This symbol indicates information that contributes to better understanding.

## 1.2 Documentation Issue Status

Version	Comment
1.0	First version.
1.1	Chapter "Web service" and "Programming" revised.

## 2 For your safety

Read the chapter on safety and follow the instructions in order to protect from personal injury and damage to equipment.

### Limitation of liability

All the components are supplied in particular hardware and software configurations appropriate for the application. Unauthorized modifications and changes to the hardware or software configuration, which go beyond the documented options, are prohibited and nullify the liability of Beckhoff Automation GmbH & Co. KG.

In addition, the following actions are excluded from the liability of Beckhoff Automation GmbH & Co. KG:

- Failure to comply with this documentation.
- Improper use.
- Untrained personnel.
- Use of unauthorized replacement parts.

## 2.1 Intended use

The CX81xx Embedded PC is a control system and is intended for mounting on a DIN rail in a control cabinet or terminal box.

The Embedded PC series is used in conjunction with Bus Terminals for recording digital or analog signals from sensors and transferring them to actuators or higher-level controllers.

The Embedded PC is designed for a working environment that meets the requirements of protection class IP20. This involves finger protection and protection against solid foreign objects up to 12.5 mm, but not protection against water. Operation of the devices in wet and dusty environments is not permitted, unless specified otherwise. The specified limits for electrical and technical data must be adhered to.

### Improper use

The Embedded PC is not suitable for operation in the following areas:

- Potentially explosive atmospheres.
- Areas with an aggressive environment, e.g. aggressive gases or chemicals.
- Living areas. In living areas, the relevant standards and guidelines for interference emissions must be adhered to, and the devices must be installed in housings or control boxes with suitable attenuation of shielding.

## 2.2 Staff qualification

All operations involving Beckhoff software and hardware may only be carried out by qualified personnel with knowledge of control and automation engineering. The qualified personnel must have knowledge of the administration of the Embedded PC and the associated network.

All interventions must be carried out with knowledge of control programming, and the qualified personnel must be familiar with the current standards and guidelines for the automation environment.

## 2.3 Safety instructions

The following safety instructions must be followed during installation and working with networks and the software.

### Mounting

- Never work on live equipment. Always switch off the power supply for the device before installation, troubleshooting or maintenance. Protect the device against unintentional switching on.
- Observe the relevant accident prevention regulations for your machine (e.g. the BGV A 3, electrical systems and equipment).
- Ensure standard-compliant connection and avoid risks to personnel. Ensure that data and supply cables are laid in a standard-compliant manner and ensure correct pin assignment.
- Observe the relevant EMC guidelines for your application.
- Avoid polarity reversal of the data and supply cables, as this may cause damage to the equipment.
- The devices contain electronic components, which may be destroyed by electrostatic discharge when touched. Observe the safety precautions against electrostatic discharge according to DIN EN 61340-5-1/-3.

### Working with networks

- Limit physical and electronic access to all devices to an authorized group of persons.
- Change the default passwords to reduce the risk of unauthorized access. Regularly change the passwords.
- Install the devices behind a firewall.
- Apply the IT security precautions according to IEC 62443, in order to limit access to and control of devices and networks.

### Working with the software

- Use up-to-date security software. The safe function of the Embedded PC can be compromised by malicious software such as viruses or Trojans.
- The sensitivity of an Embedded PC against malicious software increases with the number of installed and active software.
- Uninstall or disable unnecessary software.

Further information about the safe handling of networks and software can be found in the Beckhoff Information System:

<http://infosys.beckhoff.com>

Document name
Documentation about IPC Security

### 3 Transport and storage

#### Transport

#### NOTE

##### Short circuit due to moisture

Moisture can form during transport in cold weather or in the event of large temperature fluctuations.

Avoid moisture formation (condensation) in the Embedded PC, and leave it to adjust to room temperature slowly. If condensation has occurred, wait at least 12 hours before switching on the Embedded PC.

Despite the robust design of the unit, the components are sensitive to strong vibrations and impacts. During transport the Embedded PC must be protected from

- mechanical stress and
- use the original packaging.

Table 1: Dimensions and weight of the CX8190 Embedded PC.

	CX8190
Dimensions (W x H x D)	71 mm x 100 mm x 73 mm
Weight	230 g

#### Storage

- The battery should be removed if the Embedded PC is stored at temperatures above 60 °C. The battery should be stored separate from the Embedded PC in a dry environment at a temperature between 0 °C and 30 °C.  
The preset date and time are lost if the battery is removed.
- Store the Embedded PC in the original packaging.

## 4 Product overview

CX8100 designates a product family of Embedded PCs based on a 32-bit ARM CPU. The CX8100 Embedded PC is programmable and is able to execute its own control program. In addition to that the Embedded PC acts as a slave device of a higher-level fieldbus system.

The CX8100 Embedded PC has the following basic configuration:

- a 512 MB MicroSD card,
- an Ethernet interface
- as well as two switched Ethernet interfaces (2 x RJ45, switched).

You can use the CX8100 Embedded PCs as decentralized controllers and in this way ensure that the local program continues to be executed on the CX8100 in the event of an interruption in the higher-level fieldbus system.

The operating system is Microsoft Windows Embedded Compact 7. Because there is no monitor port, the operating system and its "virtual" display can only be accessed via the network. Beckhoff Device Manager and Remote Display (Cerhost)

The Embedded PC features an internal 1-second UPS as persistent data memory. The 1-second UPS enables persistent data to be saved to the MicroSD card in the event of a power failure.

### Power supply terminal

The power supply terminal for the Embedded PC is located on the right-hand side. Bus Terminals (K-bus) or EtherCAT Terminals (E-bus) can be attached on the right-hand side of the power supply terminal. The power supply terminal automatically recognizes the respective bus system (K-bus or E-bus).

The use of EtherCAT Terminals (E-bus) enables further options, such as the implementation of different topologies, the integration of further bus systems such as CANopen, PROFIBUS and PROFINET and – with the EtherCAT Box Modules – connection to the IP67 world.

### Fieldbus interface

CX8100 devices are being prepared for further fieldbus systems such as EtherCAT (slave), PROFINET, EtherNet/IP, CANopen, PROFIBUS and other communication systems.

Available fieldbus systems:

- [CX8110](#): EtherCAT
- [CX8180](#): RS232/485
- [CX8190](#): Ethernet (Realtime Ethernet, ADS UDP, ADS TCP, EAP, Web Services)

### Programming

The CX8100 Embedded PCs are programmed according to the high-performance IEC 61131-3 standard. The TwinCAT 3 automation software forms the basis for the programming of the Embedded PC.

### Configuration

The CX8100 Embedded PC is commissioned via the Ethernet interface. The fieldbus interface and all connected devices such as EtherCAT Terminals or Bus Terminals are then read out via TwinCAT 3. The configuration is stored on the Embedded PC after the parameterization. The configuration thus created can be accessed again later.

The shortest usable task time is 500  $\mu$ s, although this is only achievable with a very small system load. A task time of 1 to 50 ms is recommended for the I/O data. Other tasks can also be set slower. When using shorter cycle times, the total system load is to be observed.

If too short a cycle time is selected, the Web visualization and Remote Display may operate very slowly or cause timeouts. The user is responsible for configuring his system such that it is not overloaded.

## 4.1 Structure

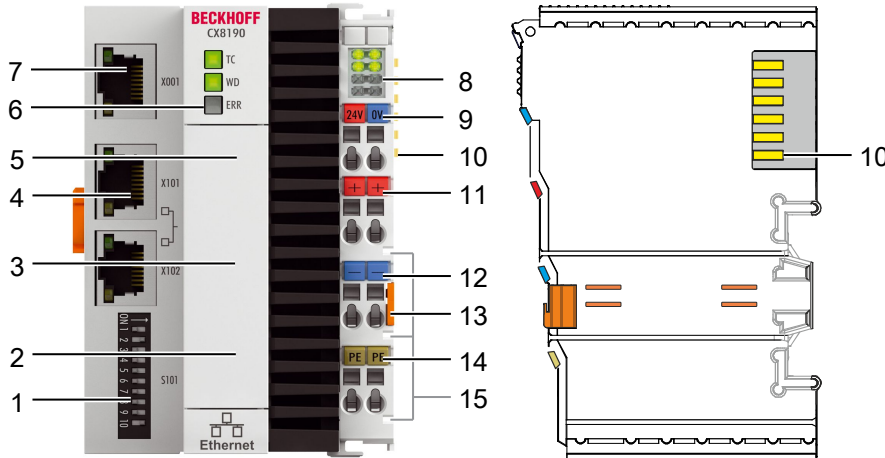


Fig. 1: Sample configuration of a CX8190 Embedded PC.

Table 2: Legend for the configuration.

No.	Component	Description
1	DIP switch [▶ 27] (S101).	You can set the IP address for the X101/X102 switched Ethernet interfaces with the DIP switch.
2	Battery compartment [▶ 60] (under the front flap).	Power supply for the battery-backed clock for time and date.
3	MicroSD card slot [▶ 17] (under the front flap).	Slot for industrial MicroSD cards.
4	Ethernet interfaces RJ45 [▶ 14] (X101, X102).	For the connection to local networks. Realtime-Ethernet-capable.
5	Reset button [▶ 17]	This switches the Embedded PC to Config mode.
6	Diagnostic LEDs [▶ 56].	Diagnostic LEDs. You can create your own diagnosis messages for the diagnostic LEDs WD and ERR (see: <a href="#">Control diagnostic LEDs [▶ 49]</a> ).
7	Ethernet interface [▶ 14] (X001).	Interface for commissioning and programming the Embedded PC.
8	Diagnostic LEDs, power supply terminal [▶ 56].	Diagnosis of the power supply for the Embedded PC and the terminal bus. Status of the E-bus and K-bus communication.
9	Spring-loaded terminals, +24 V and 0 V	Power supply for Embedded PC.
10	Terminal bus (K-bus or E-bus)	Interface for EtherCAT Terminals or Bus Terminals. Data exchange and supply.
11	Spring-loaded terminal, +24 V	Power supply for Bus Terminals via power contact.
12	Spring-loaded terminal, 0 V	Power supply for Bus Terminals via power contact.
13	Terminal release	Releases the power supply terminal and therefore the Embedded PC from the mounting rail.
14	Spring-loaded terminal, PE	Spring-loaded terminal for power contact PE.
15	Power contacts, +24 V, 0 V, PE	Power contacts for Bus Terminals.



## 4.2 Name plate

The CX8190 Embedded PC features a name plate on the left-hand side of the housing.

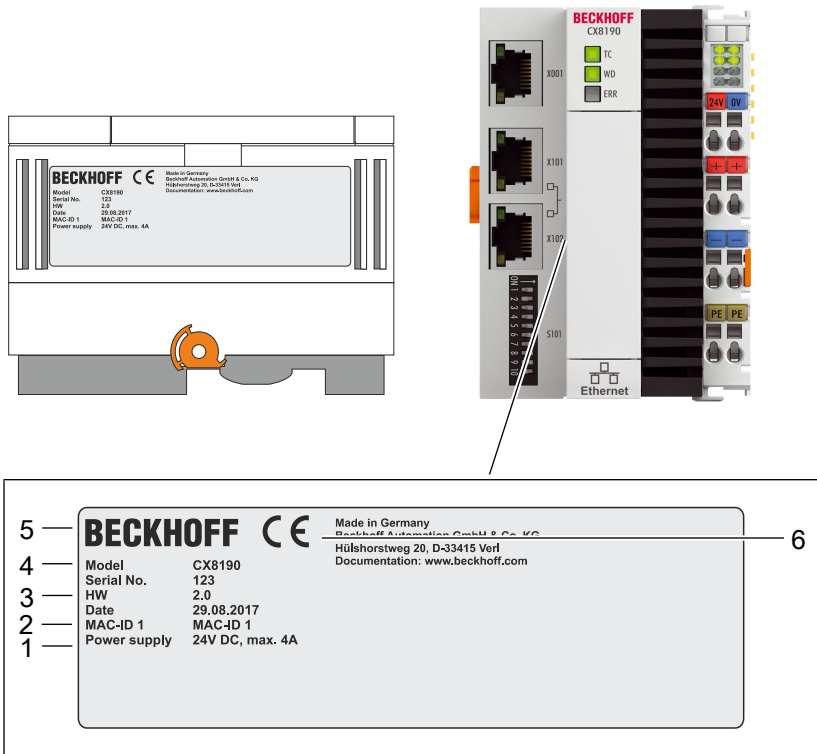


Fig. 2: CX8190 name plate.

Table 3: Legend for the name plate.

No.	Description
1	Information on the power supply unit. 24 V DC and 4 A max.
2	MAC address of the Ethernet interface X001. By default, the host name is formed from CX plus the last 3 bytes of the MAC address: for example, the MAC address: 00-01-05-aa-bb-cc results in the host name <b>CX-aabbcc</b> .
3	Information on: <ul style="list-style-type: none"> <li>• serial number,</li> <li>• hardware version</li> <li>• and date of manufacture.</li> </ul>
4	Information on the model. The last two numbers code the version of the Embedded PC.
5	Vendor data including address.
6	CE conformity.

## 4.3 Ethernet interfaces

You can program and commission the CX8190 Embedded PC via the X001 Ethernet interface. The Ethernet interface achieves speeds of 10 / 100 Mbit.

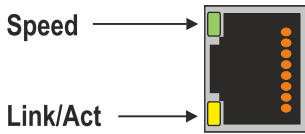


Fig. 3: Ethernet interface X001, X101, X102.

The LEDs on the left of the interfaces indicate the connection status. The lower LED (LINK/ACT) indicates whether the interface is connected to a network. If this is the case the LED is yellow. The LED flashes when data transfer on the interface is in progress.

The upper LED (SPEED) indicates the connection speed. The LED is not lit if the speed is 10 Mbit. At 100 Mbit the LED is green.



Fig. 4: Ethernet interface, pin numbering.

### Ethernet interface X001

Table 4: Ethernet interface X001, pin assignment.

PIN	Signal	Description
1	TD +	Transmit +
2	TD -	Transmit -
3	RD +	Receive +
4	connected	reserved
5		
6	RD -	Receive -
7	connected	reserved
8		

### Ethernet interfaces X101 and X102

Both Ethernet interfaces are switched and independent of each other. Both Ethernet interfaces reach speeds of 100 Mbit.

Protocols such as Realtime-Ethernet, ADS UDP/TCP, Modbus TCP Client/Server or open TCP/IP-UDP/IP communication are supported.

Table 5: Ethernet interfaces X101 and X102, pin assignment.

PIN	Signal	Description
1	TD +	Transmit +
2	TD -	Transmit -
3	RD +	Receive +
4	connected	reserved
5		
6	RD -	Receive -
7	connected	reserved
8		

**Transmission standards****10Base5**

The transmission medium for 10Base5 consists of a thick coaxial cable ("yellow cable") with a max. transmission speed of 10 Mbaud arranged in a line topology with branches (drops) each of which is connected to one network device. Because all the devices are in this case connected to a common transmission medium, it is inevitable that collisions occur often in 10Base5.

**10Base2**

10Base2 (Cheaper net) is a further development of 10Base5, and has the advantage that the coaxial cable is cheaper and, being more flexible, is easier to lay. It is possible for several devices to be connected to one 10Base2 cable. It is frequent for branches from a 10Base5 backbone to be implemented in 10Base2.

**10BaseT**

Describes a twisted pair cable for 10 Mbaud. The network here is constructed as a star. It is no longer the case that every device is attached to the same medium. This means that a broken cable no longer results in failure of the entire network. The use of switches as star couplers enables collisions to be reduced. Using full-duplex connections they can even be entirely avoided.

**100BaseT**

Twisted pair cable for 100 Mbaud. It is necessary to use a higher cable quality and to employ appropriate hubs or switches in order to achieve the higher data rate.

**10BaseF**

The 10BaseF standard describes several optical fiber versions.

**Short description of the 10BaseT and 100BaseT cable types**

Twisted pair copper cable for star topologies, where the distance between two devices may not exceed 100 meters.

**UTP**

Unshielded twisted pair

This type of cable belongs to category 3, and is not recommended for use in an industrial environment.

**S/UTP**

Screened/unshielded twisted pair (screened with copper braid)

Has a general screen of copper braid to reduce influence of external interference. This cable is recommended for use with Bus Couplers.

**FTP**

Foiled shielded twisted pair (screened with aluminum foil)

This cable has an outer screen of laminated aluminum and plastic foil.

**S/FTP**

Screened/foiled-shielded twisted pair (screened with copper braid and aluminum foil)

Has a laminated aluminum screen with a copper braid on top. Such cables can provide up to 70 dB reduction in interference power.

**STP**

Shielded twisted pair

Describes a cable with an outer screen, without defining the nature of the screen any more closely.

**S/STP**

Screened/shielded twisted pair (wires are individually screened)

This identification refers to a cable with a screen for each of the two wires as well as an outer shield.

**ITP**

Industrial Twisted-Pair

The structure is similar to that of S/STP, but, in contrast to S/STP, it has only one pair of conductors.

## 4.4 MicroSD card

In the basic configuration the CX81xx contains a MicroSD card with 512 MB. You can order it as an option with larger cards (up to 8 GB).

The cards employed are SLC memory with extended temperature range for industrial applications. Use exclusively MicroSD cards approved by Beckhoff.

Example of a MicroSD card:



Fig. 5: MicroSD card for the CX81xx.

Order designation	Capacity	Description
CX1900-0123	1 GB	MicroSD card (SLC memory) with extended temperature range for industrial applications instead of the 512 MB card (ordering option)
CX1900-0125	2 GB	
CX1900-0127	4 GB	
CX1900-0129	8 GB	
Order designation	Capacity	Description
CX1900-0122	512 MB	MicroSD card (SLC memory) with extended temperature range for industrial applications as spare part.
CX1900-0124	1 GB	
CX1900-0126	2 GB	
CX1900-0128	4 GB	
CX1900-0130	8 GB	

## 4.5 Reset button

Use the Reset button to activate Config mode. You can use this function if the PLC program unexpectedly causes an error. To do this, keep the Reset button pressed during the restart for an extended period.

**Activate Config mode as follows:**

1. Open the front flap.
  2. Switch off the Embedded PC.
  3. Start the Embedded PC and keep the Reset button pressed until the ERR LED turns red and then yellow.
- ⇒ The CX81xx Embedded PC is put into Config mode.

## 5 Commissioning

### 5.1 Mounting

#### 5.1.1 Dimensions

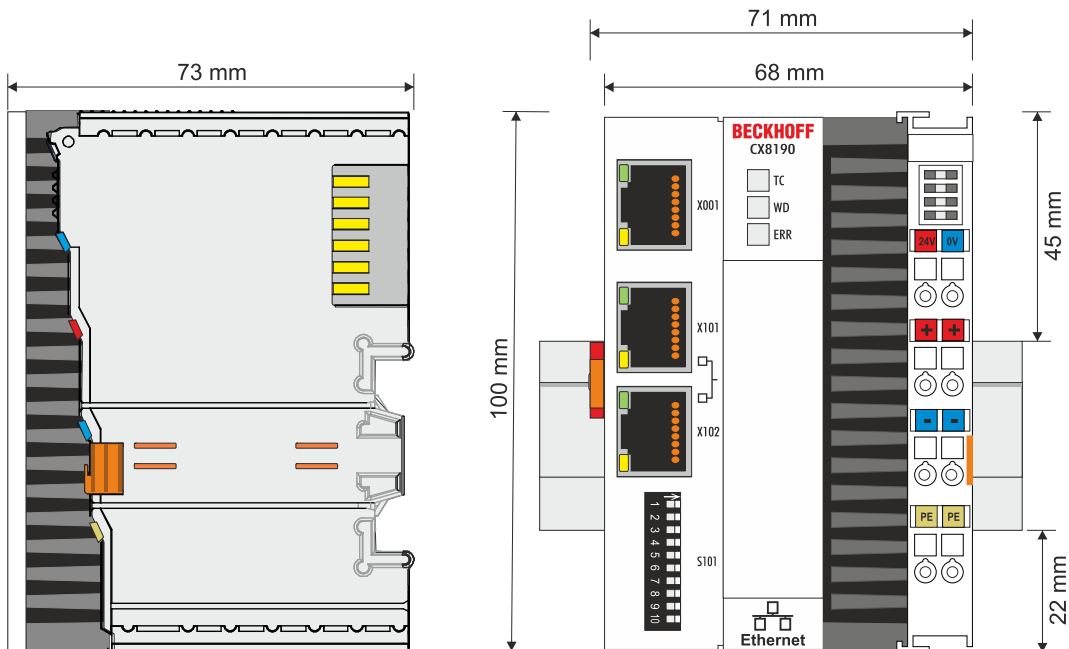


Fig. 6: Dimensions of the CX81xx Embedded PC.

Technical drawings in DWG and STP formats can be found at:

<http://www.beckhoff.com>

### 5.1.2 Note the permissible installation positions

**i** **Increased heat generation**

The Embedded PC may overheat if the installation position is incorrect or the minimum distances are not adhered to.

Ensure adequate ventilation. A horizontal installation position is ideal. Leave at least 30 mm clearance above and below the Embedded PC.

Note the following specifications for the control cabinet:

- Keep to the prescribed ambient temperature. Measure the temperature below the Embedded PC at a distance of 30 mm to the cooling fins, in order to determine the ambient temperature correctly.
- Adhere to the minimum distances of 30 mm above and below the Embedded PCs.
- Additional electrical equipment affects the heat generation in the control cabinet. Select a suitable control cabinet enclosure depending on the application, or ensure that excess heat is dissipated from the control cabinet.

**Prescribed installation position for temperatures up to 60 °C**

Install the Embedded PC horizontally in the control cabinet on a mounting rail, in order to ensure optimum heat dissipation.

Ventilation openings are located at the top and bottom of the housing. This ensures an optimum airflow through the Embedded PC in vertical direction. In addition, a minimum clearance of 30 mm above and below the Embedded PCs is required, in order to ensure adequate ventilation.

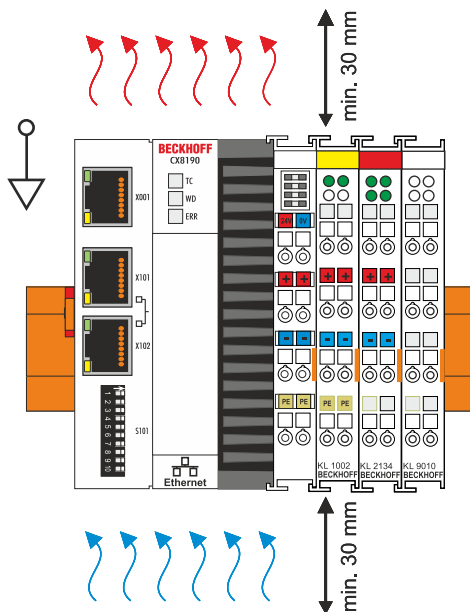


Fig. 7: CX81xx Embedded PC, horizontal installation position.

**Installation positions with reduced temperature range up to 50 °C**

You can also mount the Embedded PC vertically or horizontally on the mounting rail. Note that you can then only operate the Embedded PC up to an ambient temperature of 50 °C.

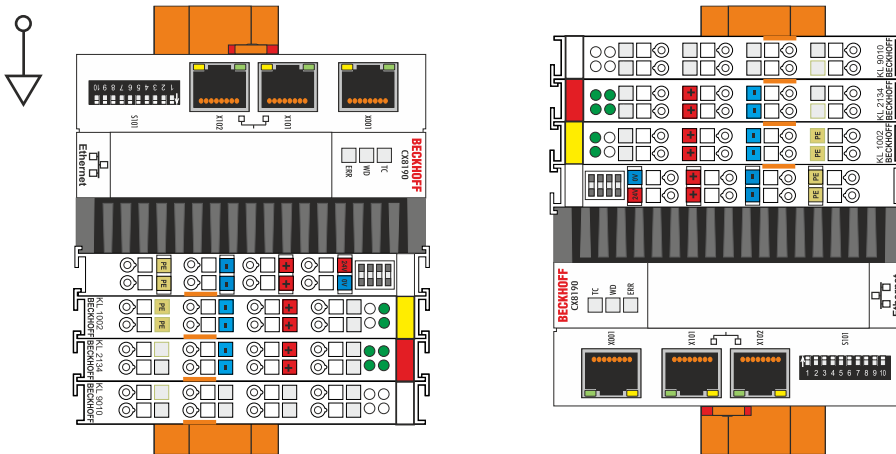


Fig. 8: CX81xx Embedded PC, vertical installation position.

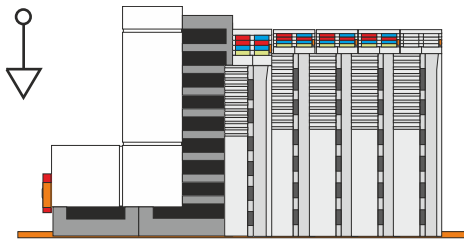


Fig. 9: CX81xx Embedded PC, horizontal installation position.

Ensure that Bus Terminals that are connected to the Embedded PC are designed for operation in vertical or horizontal position.



### 5.1.3 Securing on mounting rail

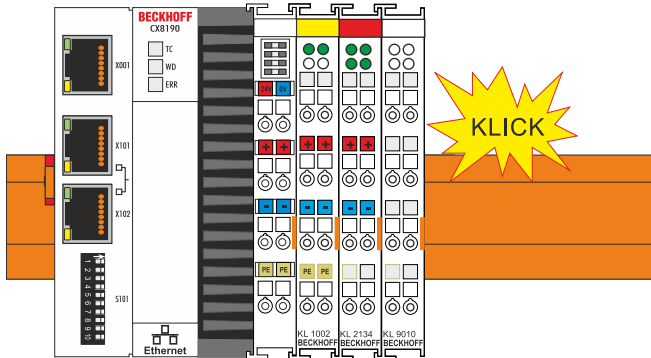
The housing is designed such that the Embedded PC can be pushed against the mounting rail and latched onto it. The Embedded PC is fastened to the DIN rail by means of a catch on the left side of the Embedded PC.

Requirements:

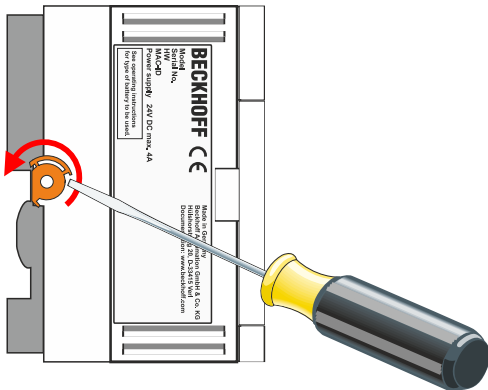
- Mounting rail of type TS35/7.5 or TS35/15 according to DIN EN 60715.

**Secure the Embedded PC on the mounting rail as follows:**

1. Place the Embedded PC at the front of the mounting rail. Slightly press the Embedded PC onto the mounting rail until a soft click can be heard and the Embedded PC has latched.



2. Subsequently, lock the catch on the left side of the Embedded PC. Use a screwdriver to do this.



⇒ Double-check the correct installation and latching of the Embedded PC on the mounting rail.

## 5.2 Connecting the power supply

### **i** Damage to the Embedded PCs

The Embedded PCs may be damaged during wiring. The cables for the power supply should only be connected in de-energized state.

The power supply terminals require an external voltage source, which provides 24 V DC (-15% / +20%). The power supply terminal must provide 4 A at 24 V, in order to ensure the operation of the Embedded PCs in all situations.

A 4 A fuse should be used for the power supply of the Embedded PC.

The cabling of the Embedded PC in the control cabinet must be done in accordance with the standard EN 60204-1:2006 PELV = Protective Extra Low Voltage:

- The "PE" and "0 V" conductors of the voltage source for a basic CPU module must be on the same potential (connected in the control cabinet).
- Standard EN 60204-1:2006, section 6.4.1:b stipulates that one side of the circuit, or a point of the energy source for this circuit must be connected to the protective earth conductor system.

### Connection example

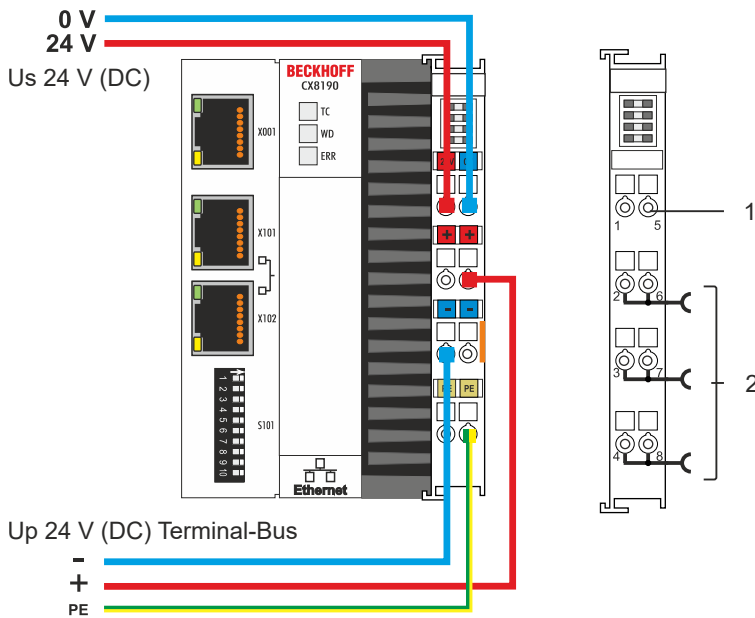


Table 6: Legend for the connection example

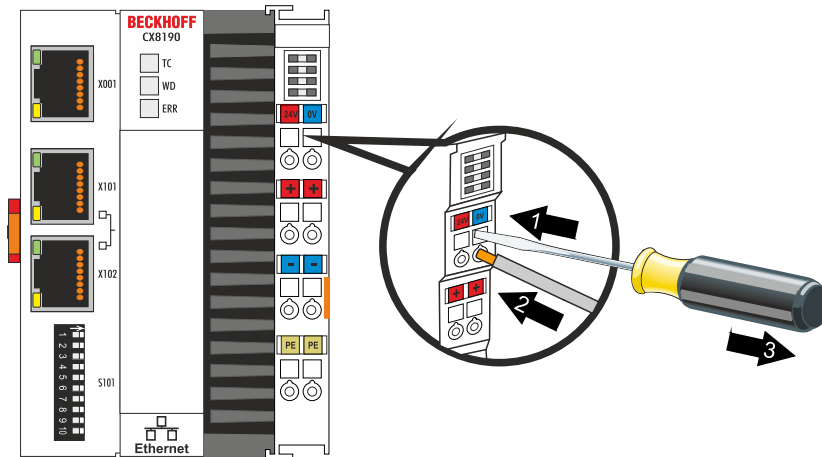
No.	Description
1	The upper spring-loaded terminals identified with "24 V" and "0 V" supply the Embedded PC and the terminal bus (data transfer via K-bus or E-bus).
2	The spring-loaded terminals identified as "+", "-", and "PE" supply the Bus Terminals via the power contacts and the sensors or actuators connected to the Bus Terminals.

**Opening and closing spring-loaded terminals:**

The cables of an external voltage source are connected to the power supply unit with spring-loaded terminals. Connect the cables as follows:

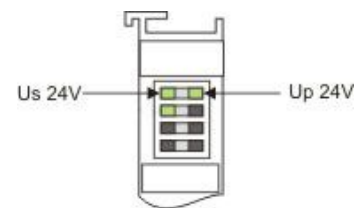
Table 7: Required wire cross-sections and strip lengths

<b>Wire cross-section</b>	0.5 ... 2.5 mm <sup>2</sup>	AWG 20 .. AWG 14
<b>Strip length</b>	8 ... 9 mm	0.33 inch



The voltage source has been connected to the power supply unit successfully when the two upper power supply terminal LEDs light up in green.

- The left LED (Us) indicates the supply of the basic CPU module and terminal bus.
- The red LED (Up) indicates the Bus Terminal supply via the power contacts.



**NOTE**

**Interrupting / switching off the power supply**

To switch off the Embedded PC, do not disconnect the ground (0 V), because otherwise current may continue to flow via the shielding, depending on the device, and damage the Embedded PC or peripheral devices.

- Always disconnect the 24 V line. Devices connected to the Embedded PC, which have their own power supply (e.g. a Panel) must have the same potential for "PE" and "0 V" as the Embedded PC have (no potential difference).

## 6 Configuration

### 6.1 Operating system

The operating system used on the CX81xx Embedded PC is Microsoft Windows Embedded Compact 7. This operating system is optimized for the CX81xx Embedded PC. This means that not all features of Windows Embedded Compact 7 are available.

#### Security

For reasons of security the CERHOST and TELNET services are deactivated in the delivery state. To reactivate these services, you need a MicroSD card reader.

#### CERHOST

CERHOST is deactivated by current images on first start-up via the registry file *CeRemoteDisplay\_Disable.reg*, which is located in the folder *RegFiles*.

To reactivate CERHOST you have to delete the file *CeRemoteDisplay\_Disable.reg* from the folder *RegFiles* and also the folder *Documents and Settings*

Then reinsert the MicroSD card in the Embedded PC and reboot. The Embedded PC creates a new *Document and Settings* directory and then reboots automatically.

The Embedded PC is then accessible again via CERHOST.

#### TELNET

TELNET is deactivated by current images on first start-up via the registry file *Telnet\_Disable.reg*, which is located in the folder *RegFiles*.

To reactivate TELNET you have to delete the file *Telnet\_Disable.reg* from the folder *RegFiles* and also the folder *Documents and Settings*.

Then reinsert the MicroSD card in the Embedded PC and reboot. The Embedded PC creates a new *Document and Settings* directory and then reboots automatically.

### 6.1.1 Features included

Features	CX81x0
ATL	X
MFC	X
XML DOM	X
XML Minimal Parser	X
COM	X
DCOM	X
COM Storage	X
Winsock	X
TCP/IP	X
TCP/IPv6	X
Firewall	X
Network Utilities (IpConfig, Ping, Route)	X
Object Exchange Protocol OBEX	-
Message Queuing MSMQ	-
<b>UPnP</b>	
Control Point	-
Device Host	X
<b>SOAP</b>	
Client	-
Server	-
<b>Server</b>	-
File Server (SMB/CIFS)	X
FTP Server	X
Print Server (SMB/CIFS)	-
RAS Server / PPTP Server	X
Simple Network Time Protocol (SNTP)	X
SNTP Client Service	X
Simple Network Management Protocol (SNMP)	X
Telnet Server	X
Web Server (HTTPD) / Active Server Pages (ASP) Support / JScript 5.8 / VBScript 5.8	X
Internet Explorer 7.0	-
NET Compact Framework	v3.5
RDP Client (Remote Desktop protocol)	-
CAB File Installer/Uninstaller	X

## 6.1.2 Update image

### NOTE

#### Loss of data

All data on the MicroSD card will be deleted. Backup any data that you may have on the MicroSD card before proceeding.

The new image will be copied directly to the MicroSD card in order to update the image of the Embedded PC.

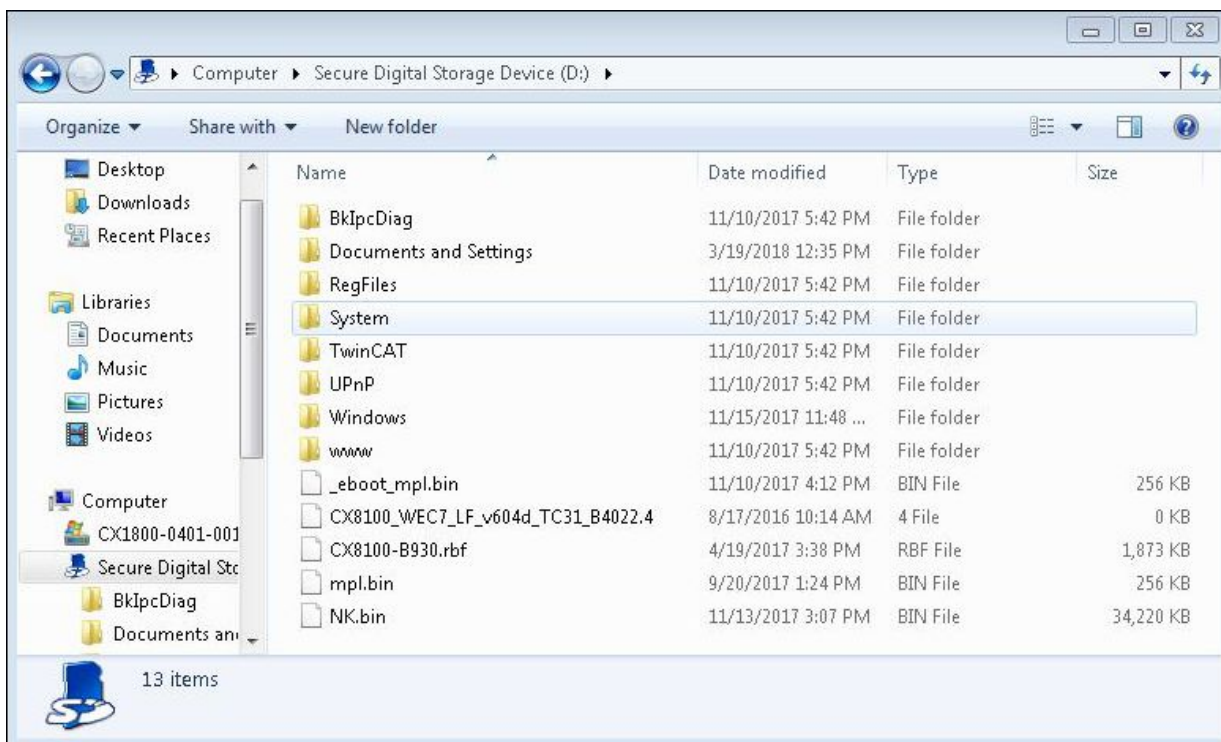
The new image is made available by Beckhoff Service. Perform the update only after consulting with Beckhoff Service.

Requirements:

- Card reader for MicroSD cards.

#### Update the image as follows:

1. Switch the Embedded PC off and remove the MicroSD card from the Embedded PC.
2. Insert the MicroSD card into an external card reader and open the MicroSD card's folder tree.
3. Delete all files and folders on the MicroSD card.



4. Copy all files and folders of the new image to the empty MicroSD card.
5. Install the MicroSD card in the Embedded PC again.
6. Start the Embedded PC.

⇒ The Embedded PC is started and saves the current hardware configuration in the folder **Documents and Settings**. The image has now been successfully updated.

## 6.2 IP address

### 6.2.1 Setting with DIP switches

You can set the IP address for the switched Ethernet interfaces X101/X102 with the DIP switches S101. The DIP switches have no meaning for the Ethernet interface X001.



Fig. 10: DIP switch S101, switches 1 to 10.

Right switch position: on "1".

Left switch position: off "0".

You can edit the last byte of the IP address with DIP switches 1 to 8. The DIP switches take priority over the settings in the operating system. The changes are only accepted after restarting the Embedded PC.

Table 8: Meaning of the DIP switch S101.

DIP switch S101	Meaning
10 on and 9 off.	DHCP active. Standard setting ex factory. The DIP switches 1 to 8 then have no meaning.
10 off and 9 off.	DHCP inactive. The fixed IP address 192.168.1.xxx and subnet mask 255.255.255.0 are used as standard. The last byte of the IP address 192.168.1.xxx is edited with DIP switches 1 to 8. You can change the first three bytes of the IP address in the <u>operating system</u> [▶ 28] or via the <u>web interface</u> (Beckhoff Device Manager) [▶ 30]. You can edit the last byte of the IP address again with the DIP switches.
10 off and 9 off 1 to 8 all on	The complete IP address is adopted from the operating system or the web interface (Beckhoff Device Manager).

#### Example

If you wish to set the IP address for the Ethernet interface X101/X102 to 192.168.1.67 using the DIP switches, you have to configure the DIP switches as follows:

DIP 1	DIP 2	DIP 3	DIP 4	DIP 5	DIP 6	DIP 7	DIP 8	DIP 9	DIP 10
On	On	Off	Off	Off	Off	On	Off	off	off

The following value for the last byte of the IP address then results from the switched-on DIP switches:  
 $2^0 + 2^1 + 2^6 = 67$

Table 9: Values for the individual DIP switches.

	DIP 1	DIP 2	DIP 3	DIP 4	DIP 5	DIP 6	DIP 7	DIP 8
Value	$2^0$	$2^1$	$2^2$	$2^3$	$2^4$	$2^5$	$2^6$	$2^7$

## 6.2.2 Setting in the operating system

The two Ethernet interfaces X001 and X101/X102 are displayed with Windows Embedded Compact 7 as EMAC1 and TCCCATMP1.



Fig. 11: Ethernet interfaces with Windows Embedded Compact 7.

### EMAC1 (X001)

As standard, DHCP is active and the IP address is assigned automatically. You can deactivate DHCP and assign a static IP address.

### TCCCATMP1 (X101/102)

As standard the first three bytes of the IP address (standard: 192.168.1) are assigned in the operating system. The last byte of the IP address (192.168.1.xxx) can be set using the DIP switches.

The DIP switches are set ex factory such that DHCP is active for the Ethernet interfaces (X101, X102). The DIP switches take priority over the settings in the operating system. As a result, the settings in the operating system or via the web interface are not adopted.

You have to set the DIP switches appropriately in order to set the last byte of the IP address in the operating system. Set the DIP switches 10 and 9 to "off" and 1 to 8 to "on" so that the complete IP address is adopted from the operating system.

### EtherCAT interface

The EtherCAT interface is a further Ethernet interface that is not visible in the operating system for the IP addressing.



## 6.3 Web service

### 6.3.1 Starting the Beckhoff Device Manager

With the Beckhoff Device Manager an Embedded PC can be configured by remote access with the help of a web browser. Depending on the image version, access takes place via different protocols and requires different open ports. For older image versions access takes place via the HTTP protocol and Port 80 (TCP). More up-to-date image versions use HTTPS and Port 433 (TCP).

Requirements:

- Host PC and Embedded PC must be located in the same network. Depending on the version of the operating system, the network firewall must allow access via port 80 (HTTP) or port 433 (HTTPS).
- IP address or host name of the Embedded PC.

Table 10: Access data for the Beckhoff Device Manager on delivery.

Operating system	Access data
Windows Embedded Compact 7	User name: Webguest Password: 1

Start the Beckhoff Device Manager as follows:

1. On the host PC enter the IP address or the host name of the Embedded PC in the web browser, in order to start the Beckhoff Device Manager.  
 Example with IP address: **https://169.254.136.237/config**  
 Example with host name: **https://CX-16C2B8/config**
2. Enter the user name and password. The start page appears:

⇒ Continue to navigate in the menu and to configure the Embedded PC. Note that modifications only become active once they have been confirmed.

## 6.3.2 Changing the IP address of the Ethernet interfaces (X101, X102)

### **i** DIP switches take priority

The DIP switches are set ex factory such that DHCP is active for the Ethernet interfaces (X101, X102). As a result, the settings in the operating system or via the web interface are not adopted. Deactivate DHCP using the DIP switches. Set the DIP switches 10 and 9 to "off" and 1 to 8 to "on" so that the settings are adopted from the operating system or the web interface.

In this work step you will learn how to change the IP address of the Ethernet interface (X101, X102) via the web interface (Beckhoff Device Manager).

Requirements:

- Set the DIP switches correctly so that the IP address is adopted completely from the operating system.
- Start the web interface (see: Starting the Beckhoff Device Manager).

**Change the IP address as follows:**

1. Click on **Device** and then on **Connectivity**.
2. Click on the **wrench symbol** to configure the network settings.

The screenshot shows the Beckhoff Device Manager interface. On the left, there is a navigation menu with 'Device' selected. In the center, there are icons for 'System', 'Connectivity', and 'Boot Opt.'. The main area displays network settings for two interfaces:

Network	
Name	EMAC1
IPv4 Address	172.17.42.18
IPv4 Subnet Mask	255.255.252.0
IPv4 Default Gateway	172.17.40.1
DHCP	Enabled
Name	TCCCATMP1
IPv4 Address	192.168.1.0
IPv4 Subnet Mask	255.255.255.0
IPv4 Default Gateway	0.0.0.0
DHCP	Disabled
AMS Net ID	
AMS Net ID	5.48.22.246.1.1

3. Change the network settings and save your settings.

The screenshot shows a configuration dialog for the TCCCATMP1 interface. It includes a title bar with a refresh icon, a checkmark, and a close button. The settings are as follows:

MAC Address	00 01 05 30 16 f7
IPv4 Address	<input type="text" value="192.168.1.0"/>
IPv4 Subnet Mask	<input type="text" value="255.255.255.0"/>
IPv4 Default Gateway	<input type="text" value="0.0.0.0"/>
DHCP	<input type="text" value="Disabled"/>

⇒ Restart the Embedded PC so that the settings are adopted.

### 6.3.3 Enabling a remote display

In order to be able to access an Embedded PC with CE operating system by remote access, you must first activate the remote display. The remote display is disabled as standard. Remote control of an Embedded PC with CE operating system from another PC requires an active remote display. This section illustrates how the remote display can be enabled with the Beckhoff Device Manager.

Requirements:

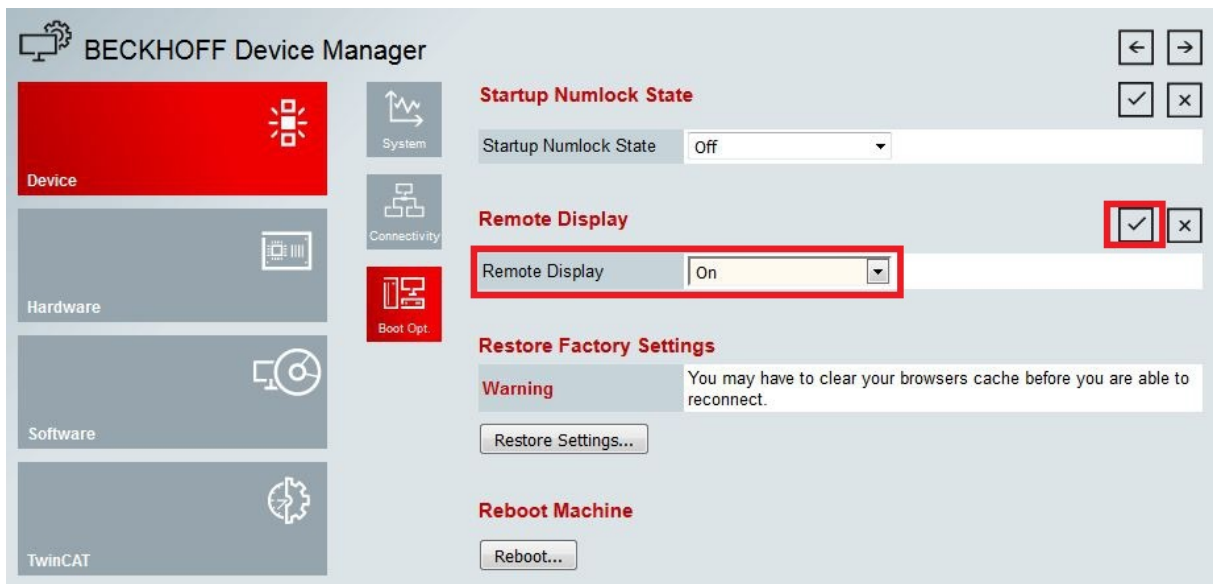
- Host PC and Embedded PC must be located in the same network. Depending on the version of the operating system, the network firewall must allow access via port 80 (HTTP) or port 433 (HTTPS).
- The IP address or the host name of the Embedded PC must be known.

Table 11: Access data for the Beckhoff Device Manager on delivery.

Operating system	Access data
Windows Embedded Compact 7	User name: Webguest Password: 1

Enable the remote display as follows:

1. On the host PC enter the IP address or the host name of the Embedded PC in the web browser, in order to start the Beckhoff Device Manager.  
Example with IP address: **https://169.254.136.237/config**  
Example with host name: **https://CX-16C2B8/config**
2. Enter the user name and password. The start page appears.
3. In the menu under **Device** click on **Boot Opt.**



4. Under **Remote Display** select the option **On** and confirm the settings.
  5. In the information window click **OK** to accept the settings.
- ⇒ You have successfully activated the remote display on the Embedded PC. Following the restart you can access your Embedded PC by remote access.

### 6.3.4 Starting a remote connection

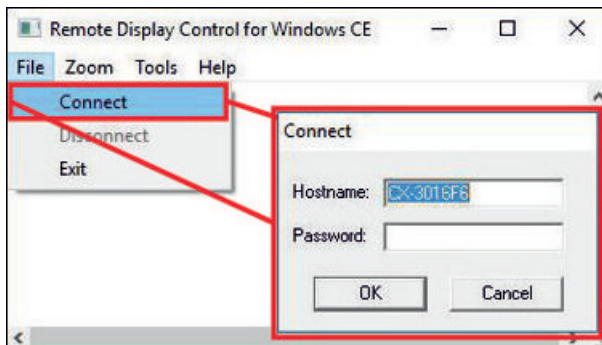
You need the program Remote Display Control (CERHOST) to start a remote connection. Only with this program you can remotely control an Embedded PC with CE operating system from another PC.

Requirements:

- Remote Display is active. See: Enabling a remote display.
- Host name of the Embedded PC.
- Remote Display Control (CERHOST). Download under:  
[https://infosys.beckhoff.com/content/1033/CX8190\\_HW/Resources/zip/5047075211.zip](https://infosys.beckhoff.com/content/1033/CX8190_HW/Resources/zip/5047075211.zip)

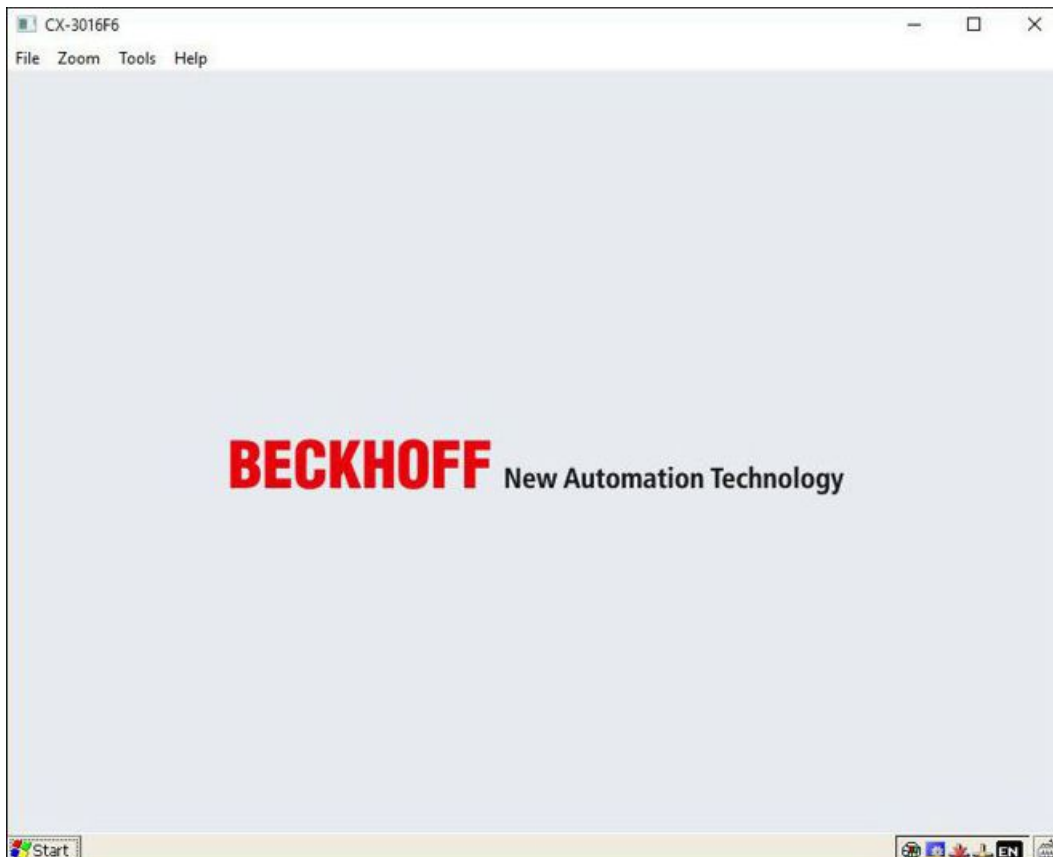
**Start the remote connection as follows:**

1. Unpack the zip file on the host PC and run *cerhost.exe*.
2. Click on **File** in the menu bar and then on **Connect**.



3. Enter the host name of the Embedded PC in the **Hostname** field.

⇒ The remote connection is started and the Windows Embedded CE 7 start screen appears.



## 6.4 TwinCAT

### 6.4.1 Connecting to the CX81xx

Before you can work with the CX81xx you must connect your local computer to the CX81xx (target system). Then you can search for devices such as EtherCAT terminals with the help of the IP address or the host name.

The local PC and the target system must be connected to the same network or directly to each other via an Ethernet cable. In TwinCAT a search can be performed for all devices in this way and project planning subsequently carried out.

Requirements for this step:

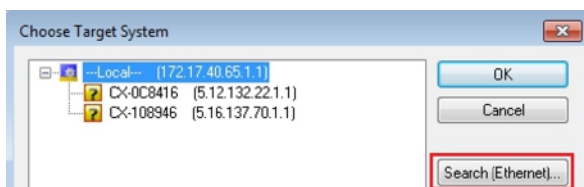
- TwinCAT 3 must be in Config mode.
- IP address or host name of the Embedded PC.

Establish a connection as follows:

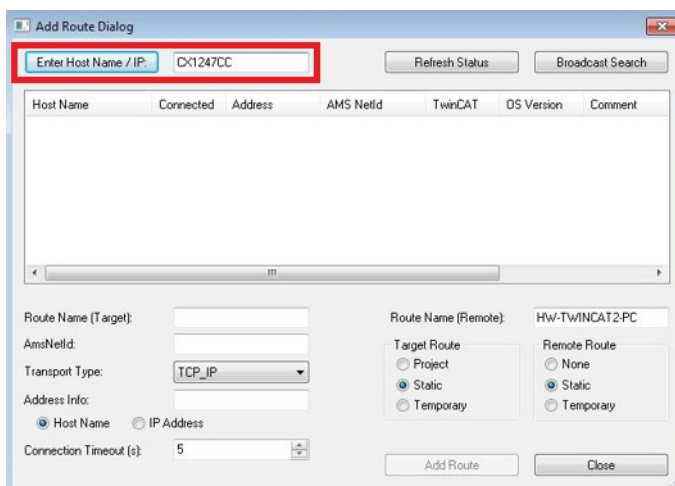
1. In the menu at the top click on **File > New > Project** and create a new TwinCAT XAE project.
2. In the tree view on the left click on **SYSTEM**, and then **Choose Target**.



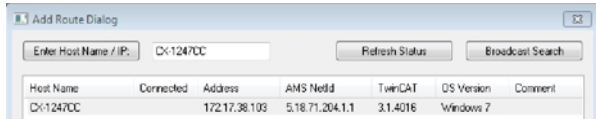
3. Click on **Search (Ethernet)**.



4. Type the host name or the IP address of the device into the **Enter Host Name / IP** box and press **[Enter]**.



5. Mark the device found and click on **Add Route**.



The **Logon Information** window appears.

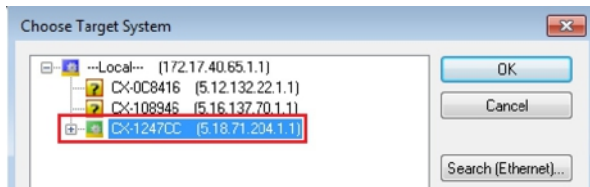
Enter the user name and password for the CX in the **User Name** and **Password** fields and click **OK**.



The following information is set as standard in CX devices:

**User name:** Administrator **Password:** 1

6. If you do not wish to search for any further devices, click on **Close** to close the **Add Route window**. The new device is displayed in the **Choose Target System** window.
7. Select the device you want to specify as target system and click **OK**.



- ⇒ You have successfully searched for a device in TwinCAT and inserted the device as the target system. The new target system and the host name are displayed in the menu bar.



Using this procedure you can search for all available devices and also switch between the target systems at any time. Next, you can append the device to the tree view in TwinCAT.



### 6.4.2 Scanning for devices

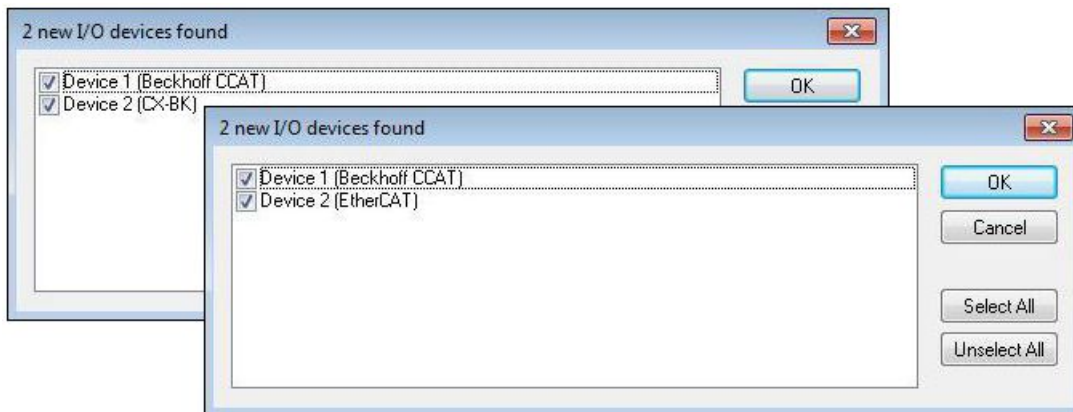
As soon as the CX81xx has been inserted as the target system in TwinCAT you can scan for further devices and in this way, for example, insert all the EtherCAT Terminals or Bus Terminals connected to the CX81xx into the TwinCAT tree view.

Requirements for this step:

- The CX81xx is connected as the target system to TwinCAT (see: [Connecting to the CX81xx \[P. 33\]](#)).
- TwinCAT 3 is in ConfigMode.

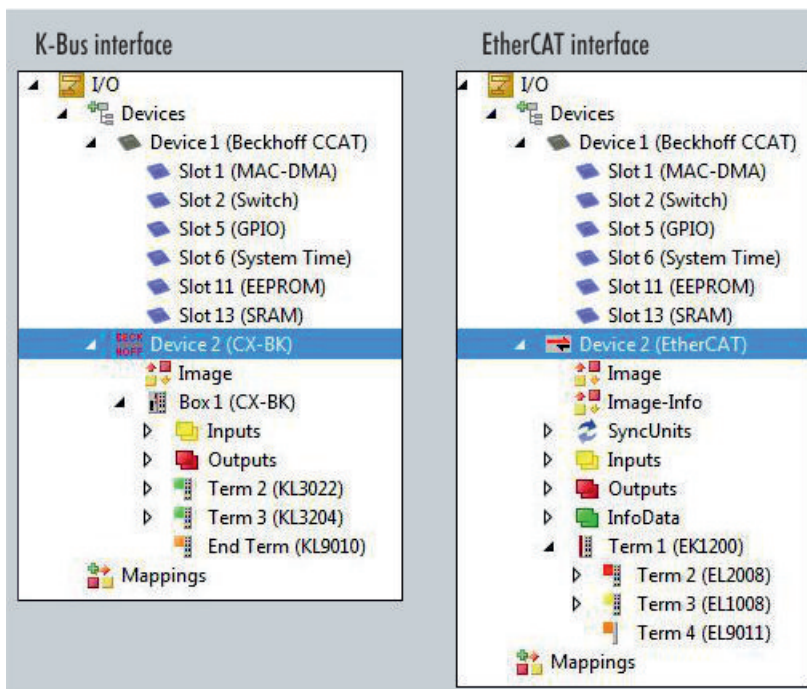
Scan for devices as follows:

1. In the tree view on the left, right-click on **Devices** under **I/O**.
2. In the context menu click on **Scan**.
3. Select the devices you want to use and confirm the selection with **OK**.



Depending on whether EtherCAT terminals or Bus Terminals are connected to the CX81xx, the K-bus interface (Bus Terminals) or the EtherCAT interface (EtherCAT terminals) will be found.

4. Confirm the request with **Yes**, in order to look for boxes.
  5. Confirm the request whether to enable FreeRun with **Yes**.
- ⇒ The devices will be inserted into the tree view. Depending on the connected terminals, either a Bus Coupler or an EtherCAT coupler with the associated terminals will be inserted.



In the next step you can create a small program.

### 6.4.3 Creating a PLC project

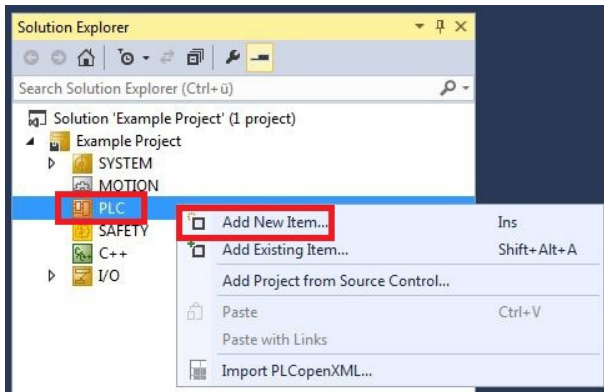
The next steps describe how to create a PLC project in TwinCAT and add it in the tree view.

Requirements for this step:

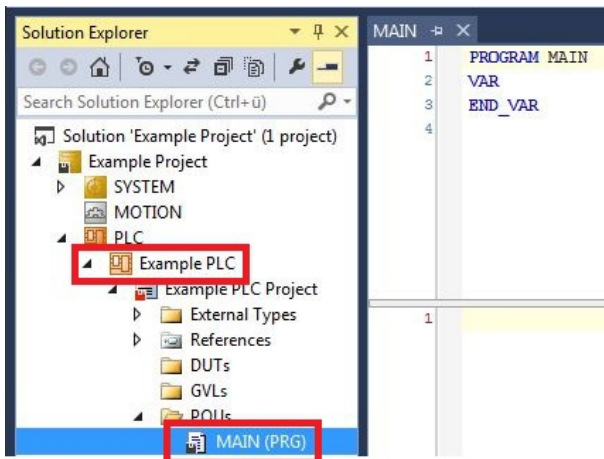
- A newly created TwinCAT XAE project.

**Create a PLC project as follows:**

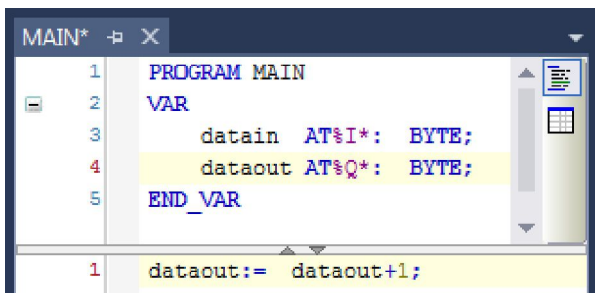
1. Right-click on **PLC** in the tree view.
2. In the context menu click on **Add New Item** and select the **Standard PLC Project**.



3. In the tree view click on the newly created PLC project, then double-click on **MAIN (PRG)** under **POUs**.

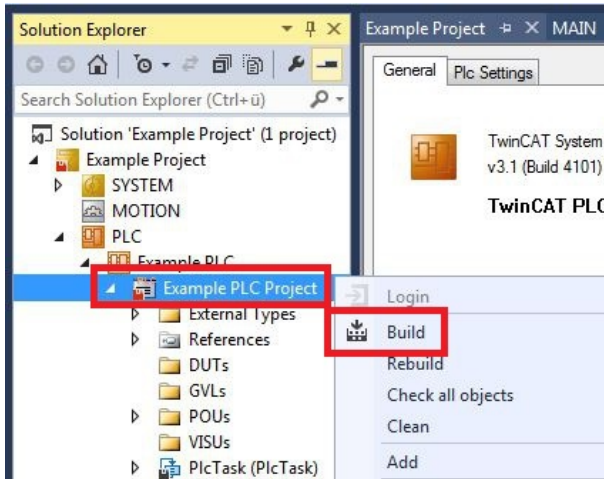


4. Write a small program, as shown in the diagram below.

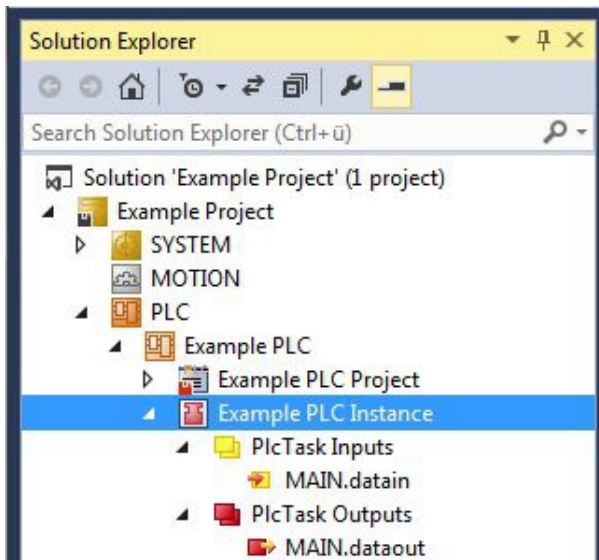




5. In the tree view right-click on the PLC project, then click on **Build** in the context menu.



⇒ You have successfully created a PLC project and added the project in TwinCAT. A PLC instance is created with the variables for the inputs and outputs from the PLC project.



In the next step you can link the variables with the hardware.

## 6.4.4 Linking variables

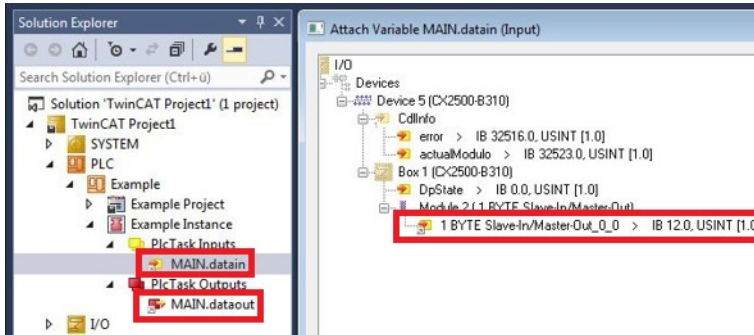
Once the PLC project has been successfully appended in TwinCAT you can link the newly created input and output variables from the PLC project with the inputs and outputs of your hardware.

Requirements for this step:

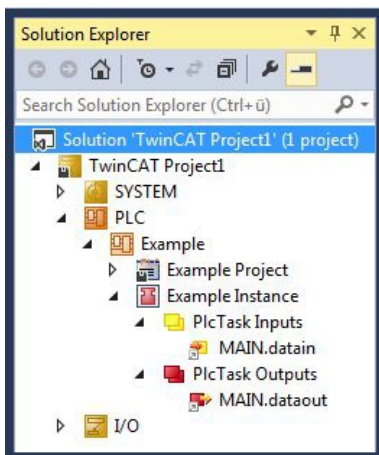
- An appended PLC project in TwinCAT.

Link the variables as follows:

1. Double-click on the input or output variables in the tree view under **PLC**.  
The **Attach Variable** window appears and shows which inputs or outputs can be linked with the variables from the PLC project.



2. Double-click on the inputs or outputs of the hardware in the **Attach Variable** window.  
Link the input variables with the inputs and the output variables with the outputs of the hardware.



Variables that are already linked are indicated with a small arrow icon in TwinCAT.

3. In the toolbar click on **Activate Configuration**.



4. Confirm the request whether TwinCAT is to start in Free Run mode with **Yes**.  
⇒ You have successfully linked variables with the hardware. Use Activate Configuration to save and activate the current configuration.

Next, the configuration can be loaded to the Embedded PC in order to start TwinCAT automatically in Run mode and then start the PLC project.

### 6.4.5 Configuring Realtime Ethernet

The Ethernet interface (X101/X102) of the CX8190 Embedded PC supports the Realtime Ethernet protocol and can be configured as a master. The Realtime Ethernet protocol is configured in TwinCAT.

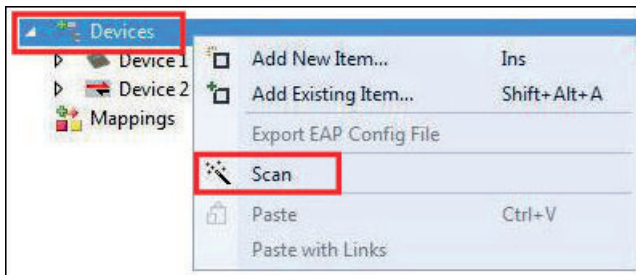
Following the configuration you can scan for Bus Couplers or EtherCAT couplers and operate them as decentralized nodes. There is fundamentally no limit to the number of Bus Couplers or EtherCAT couplers that can be connected to the CX8190 Embedded PC. However, it is recommended to limit the number to 10 nodes.

Requirements:

- The CX8190 Embedded PC has been selected as the target system.

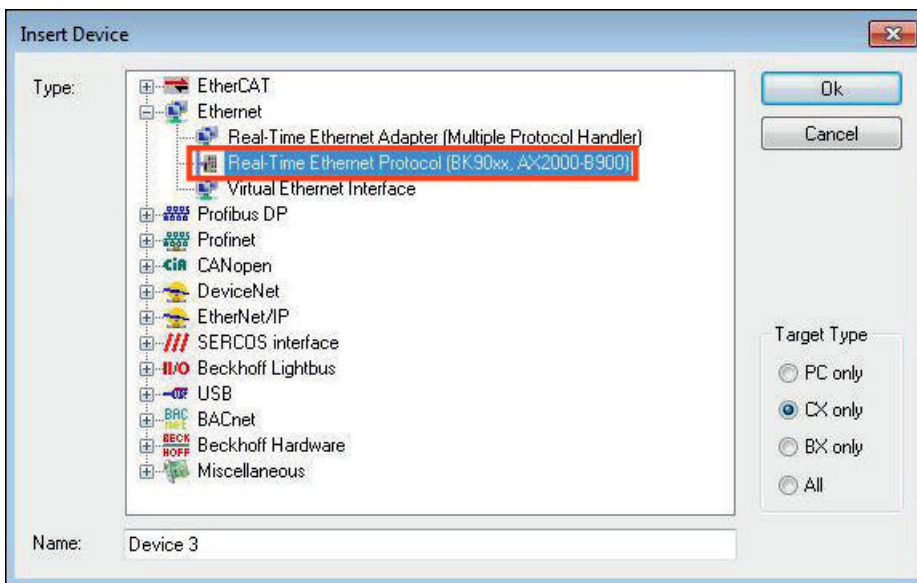
**Configure Realtime Ethernet as follows:**

1. In the tree view on the left, right-click on **Devices**.
2. Click on **Add New Item** in the context menu.



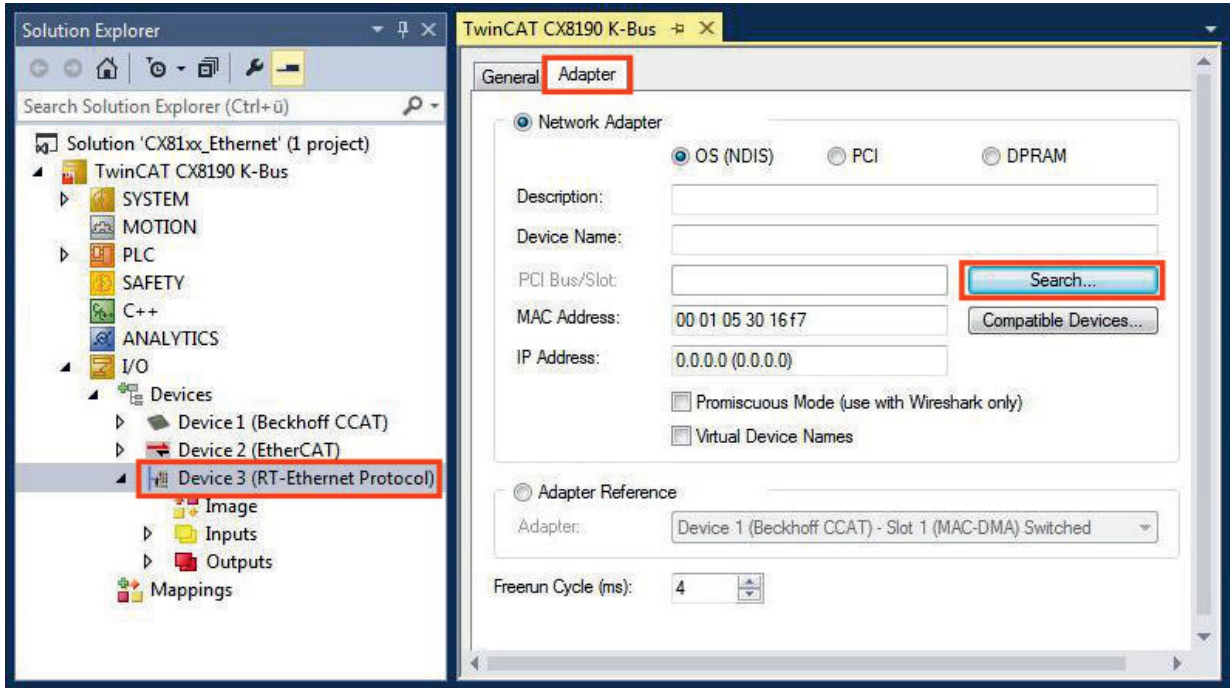
The Insert Device window appears.

3. Click on **Ethernet** in the tree view and select **Real Time Ethernet Protocol (BK90xx, AX2000-B900)**.

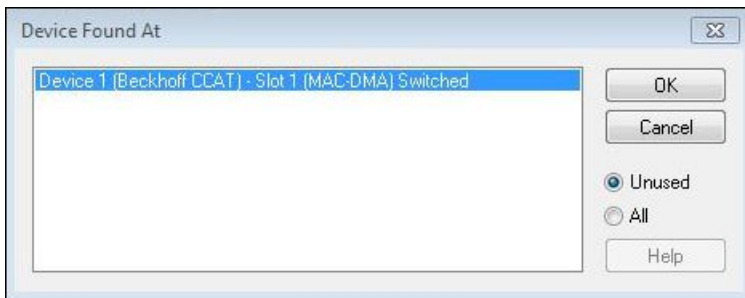


4. Click on RT-Ethernet Protocol in the tree list.

5. Click on the **Adapter** tab and then on **Search**.

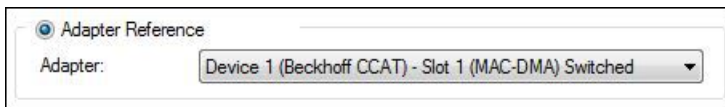


6. Select the CCAT adapter.



No adapter will be displayed if you have not created a CCAT adapter in TwinCAT. Create a CCAT adapter if you use real-time capable protocols.

⇒ The CCAT adapter appears under **Adapter Reference**.



You have successfully configured the Realtime Ethernet protocol. Connect further devices with Realtime Ethernet to the Ethernet interface (X101/X102). Then switch the CX8190 to Config mode and scan for the devices.

### 6.4.6 Configuring the EtherCAT Automation Protocol (EAP)

The Ethernet interface (X101/X102) of the CX8190 Embedded PC supports the EtherCAT Automation Protocol (EAP). The EtherCAT Automation Protocol (EAP) is configured in TwinCAT.

Data can be exchanged with other controllers in real-time via the publisher and subscriber services.

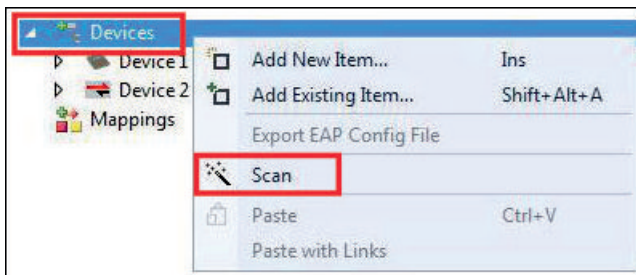
Further information on the EtherCAT Automation Protocol (EAP):  
 Product description

Requirements:

- The CX8190 Embedded PC has been selected as the target system.

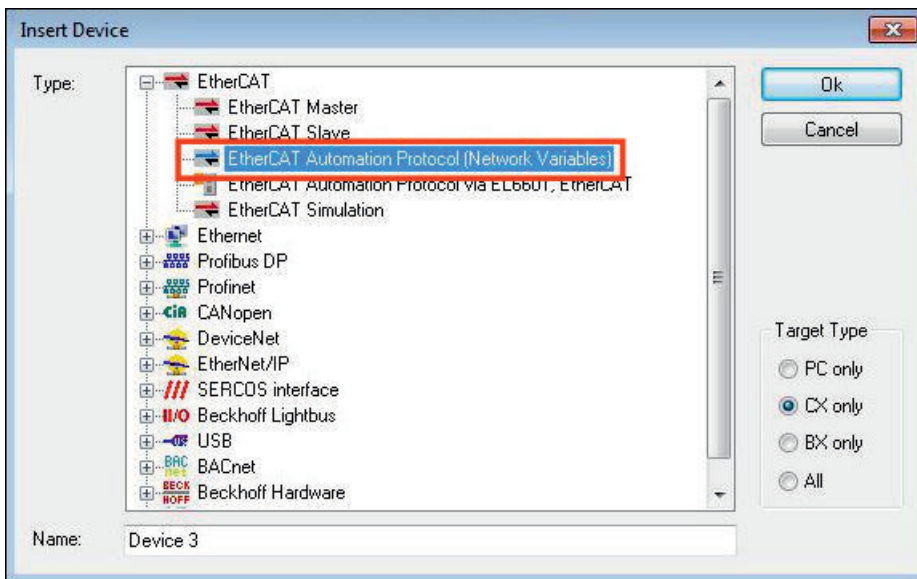
**Configure the EtherCAT Automation Protocol (EAP) as follows:**

1. In the tree view on the left, right-click on **Devices**.
2. Click on **Add New Item** in the context menu.



The Insert Device window appears.

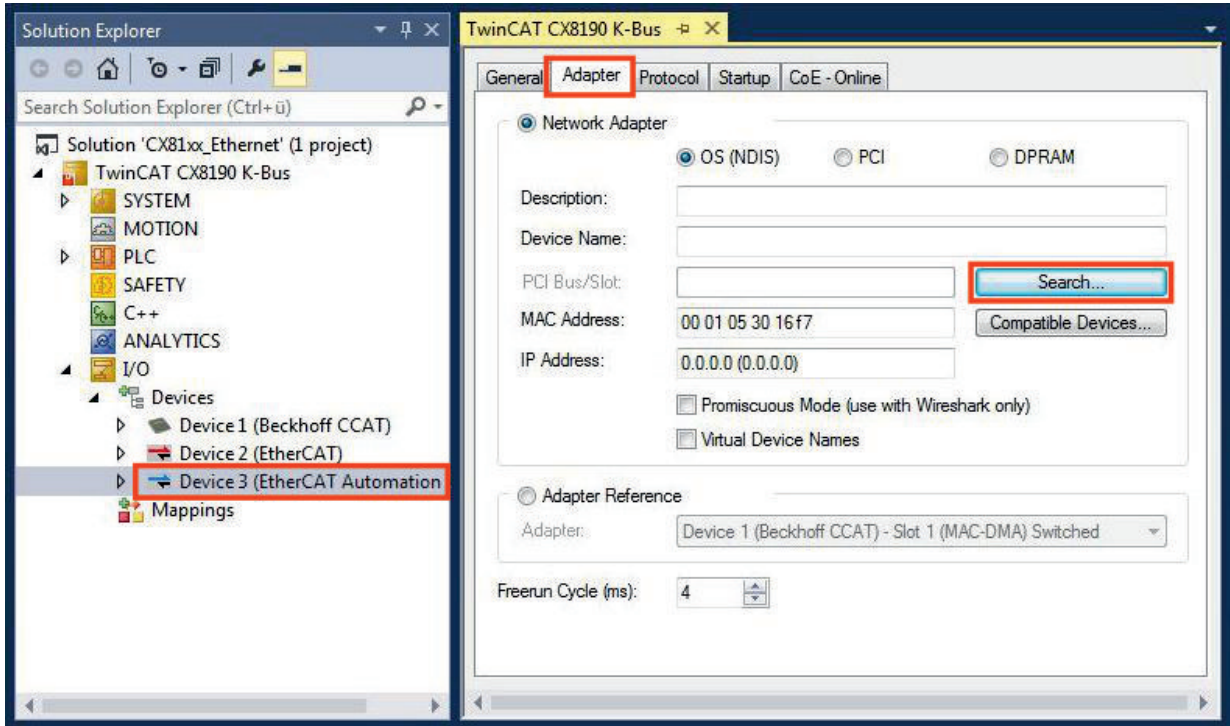
3. Click on **Ethernet** in the tree view and select **EtherCAT Automation Protocol**.



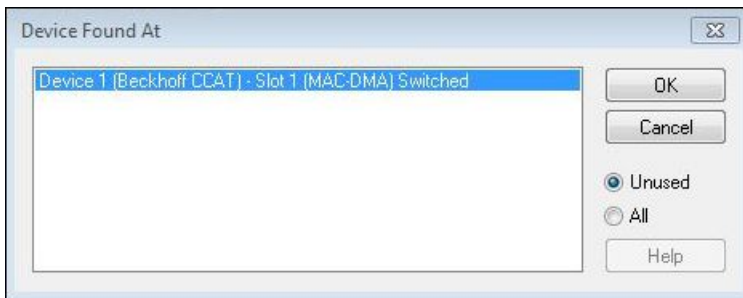
4. Click on the device **EtherCAT Automation Protocol** on the left in the tree view.



5. Click on the **Adapter** tab and then on **Search**.

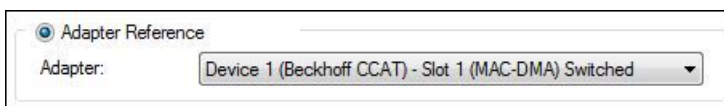


6. Select the CCAT adapter.



No adapter will be displayed for selection if you have not created a CCAT adapter in TwinCAT. Create a CCAT adapter if you use real-time capable protocols.

⇒ The CCAT adapter appears under **Adapter Reference**.



You have successfully configured the EtherCAT Automation Protocol (EAP).

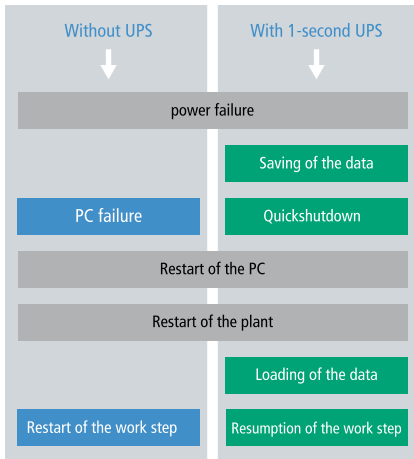
# 7 Programming

## 7.1 Seconds UPS



### Loss of data

The use of the 1-second UPS outside of the documented possibilities can lead to loss or corruption of data.  
Use only TwinCAT to control the 1-second UPS and save only persistent data with a maximum size of 1 MB.



The 1-second UPS is an UltraCap capacitor that continues to supply the processor with power in the event of a power failure.

During this period persistent data can be saved, which are available on switching on again.

Since the 1-second UPS is designed for the entire service life, the holding time is considerably longer with new devices. The capacitors age over the course of time and the holding time decreases. Therefore a maximum of 1 MB persistent data can be reliably saved over the entire service life.

Do not save any other data and do not use any other applications to control the 1-second UPS.

Please note that the 1-second UPS does not supply power to the K-bus or the E-bus and that their data may already be invalid when the 1-second UPS is activated. Also, the fieldbus system (or Ethernet) may not work or not work properly once the 1-second UPS was activated.

### Storage location and names of the files:

The persistent data are saved by default in the TwinCAT boot directory:

Development environment	File path	File name
TwinCAT 3	\\TwinCAT\3.1\Boot\Plc	Port_85x.bootdata Port_85x.bootdata-old (backup) The x in the file name stands for the number of the runtime system.

Configure the 1-second UPS as follows in order to save persistent data:

- Declare important data such as counter values in the PLC as VAR PERSISTENT. Then call the function block FB\_S\_UPS\_CX81xx cyclically in TwinCAT with the fastest task in order to control the 1-second UPS (see: [Function block \[▶ 45\]](#)).
- Select the mode in the function block in order to specify what should happen in the case of a power failure. Select the mode eSUPS\_WrPersistData\_NoShutdown for the CX81xx in order to save persistent data without error (see: [Data types \[▶ 47\]](#)).
- You can then check the validity of the variables and monitor whether the persistent variables are loaded without error (see: [PlcAppSystemInfo](#)).

Components	Version
TwinCAT on the development PC and on the control system	TwinCAT 3.1 Build 4020.16 or higher

## Saving and loading persistent data

The persistent data are saved in the Port\_85x.bootdata file on the MicroSD card. On starting the PLC the Port\_85x.bootdata file is loaded from the MicroSD card, backed up there as Port\_85x.bootdata\_old (backup) and then deleted.

Another current Port\_85x.bootdata file is not written until the system is shut down or the 1-second UPS is activated.

If no Port\_85x.bootdata file exists when starting the Embedded PC, the persistent data are invalid and will be deleted (standard setting). The reason for this is that the 1-second UPS was activated before the TwinCAT PLC was started during startup of the Embedded PC. In this case no persistent data were saved, since the system was unable to ensure sufficient buffer time for saving the data.

Always call the function block from the PLC and always use the fastest task to do so. In the case of a power failure Beckhoff recommends not calling the rest of the application in order to ensure that sufficient time remains for writing the data.

```
IF NOT FB_S_UPS_CX81xx.bPowerFailDetect THEN
  ;//Call programs and function blocks
END_IF
```

The rest of the application influences the CPU load and the CPU load in turn affects the period during which the persistent data are written.

## Loading a backup of the persistent data

A registry setting can be used to determine whether the backup file is deleted or used. The backup file is used by default (setting 0):

```
[HKEY_LOCAL_MACHINE\SOFTWARE\Beckhoff\TwinCAT\Plc]"ClearInvalidPersistentData"= 0
```

If the backup file is to be deleted, the value of "ClearInvalidPersistentData" in the registry must be set to 1.

It is also possible in TwinCAT to specify on the left in the tree view under **PLC > CX8190** whether the backup file is to be used or not.

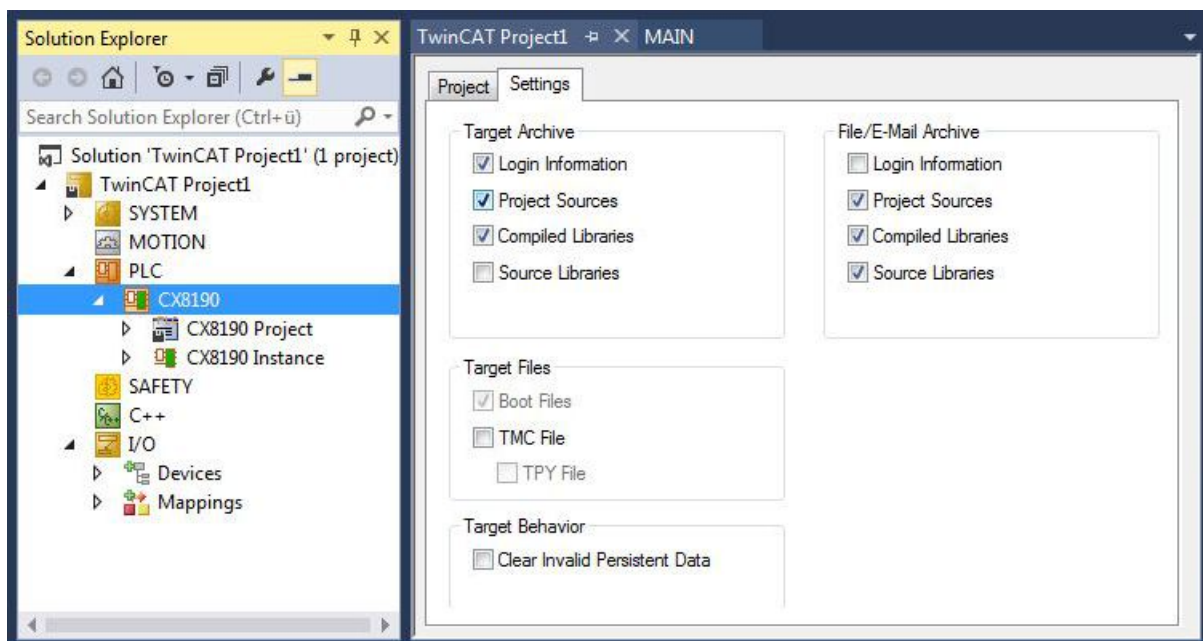


Fig. 12: Loading a backup of the persistent data. Settings in TwinCAT 3.

The backup files will be deleted if the option **Clear Invalid Persistent Data** is activated. Corresponds to registry entry 1.



## 7.1.1 Function block

### FUNCTION\_BLOCK FB\_S\_UPS\_CX81xx



The function block FB\_S\_UPS\_CX81xx can be used on CX81xx devices with second UPS, in order to control the second UPS from the PLC. This enables the persistent data to be saved according to the selected mode in the event of a power failure. The default input values of the FB\_S\_UPS\_CX81xx should be retained.

The second UPS does not have sufficient capacity for bridging power failures. Saving can take place only on MicroSD cards.

The 1-second UPS can be used only for a few seconds in the event of a power failure in order, to save persistent data. The data must be saved in the fast “persistent mode” “SPDM\_2PASS”, even though this can lead to real-time violations. Make sure you configure adequate router memory for saving the persistent data.

Regardless of the mode and therefore irrespective of whether data were saved or a quick shutdown was performed, the UPS switches off the mainboard after the capacitors have been discharged, even if the voltage has returned in the meantime.

#### NOTE

##### Loss of data

If other applications or the PLC keep further files open or write to them, file errors may occur if the 1-second UPS switches off the controller.

#### Function block modes

A QuickShutdown is performed automatically in the eSUPS\_WrPersistData\_Shutdown mode (standard setting) after the storage of the persistent data.

In the eSUPS\_WrPersistData\_NoShutdown mode only the persistent data are saved, no QuickShutdown is performed.

In eSUPS\_ImmediateShutdown mode a quick shutdown is executed immediately, without saving data.

In the eSUPS\_CheckPowerStatus mode only a check is performed as to whether a power failure has occurred. If this is the case, the function block only switches back to the PowerOK state after the expiry of tRecoverTime (10s).

#### Application under Windows CE/WEC7

Quick shutdown must not be used under Windows CE/WEC7, since in this case Windows CE/WEC7 would restart immediately once the persistent data have been saved. This can lead to errors in the persistent data. Under Windows CE/WEC7, only the mode eSUPS\_WrPersistData\_NoShutdown should be used to ensure that persistent data are saved without errors.

#### VAR\_INPUT

```
VAR_INPUT
  sNetID      : T_AmsNetId:= ''; (* '' = local netid *)
  iPLCPort    : UINT := 0; (* PLC Runtime System for writing persistent data *)
  tTimeout    : TIME := DEFAULT_ADS_TIMEOUT; (* ADS Timeout *)
  eUpsMode    : E_S_UPS_Mode := eSUPS_WrPersistData_Shutdown; (* UPS mode (w/
wo writing persistent data, w/wo shutdown) *)
  ePersistentMode : E_PersistentMode := SPDM_2PASS; (* mode for writing persistent data *)
  tRecoverTime : TIME := T#10s; (* ON time to recover from short power failure in mode eSUPS_Wr
PersistData_NoShutdown/eSUPS_CheckPowerStatus *)
END_VAR
```

**sNetID:** AmsNetID of the controller (type: T\_AmsNetID)

**iPLCPort:** Port number of the PLC runtime system (851 for the first PLC runtime system, 852 for the second PLC runtime system, ...). If no port number is specified, iPLCPort is 0. The function block then automatically determines the port of the PLC runtime system.

**tTimeout:** Timeout for writing of the persistent data or the quick shutdown.

**eUpsMode:** Defines whether persistent data are to be written and whether a quick shutdown is to be executed. The default value is eSUPS\_WrPersistData\_Shutdown, i.e. a quick shutdown is executed automatically once the persistent data have been saved. (Type: E\_S\_UPS\_Mode)

**ePersistentMode:** Mode for the writing of the persistent data. Default value is SPDM\_2PASS.

**tRecoverTime:** Time after which the UPS returns to PowerOK state in UPS modes without quick shutdown. The tRecoverTime must be greater than the maximum charging time of the UPS, otherwise the UPS may discharge too much in the event of short, consecutive power failures, which could result in the charge being insufficient for storing the persistent data.

## VAR\_OUTPUT

```
VAR_OUTPUT
    bPowerFailDetect : BOOL; (* TRUE while powerfailure is detected *)
    eState           : E_S_UPS_State := eSUPS_PowerOK; (* current ups state *)
END_VAR
```

**bPowerFailDetect:** TRUE during power failure. FALSE if the supply voltage is present.

**eState:** Internal state of the function block (type: E\_S\_UPS\_State)

## VAR\_GLOBAL

```
VAR_GLOBAL
    eGlobalSupsState : E_S_UPS_State; (*current ups state*)
END_VAR
```

**eGlobalSupsState:** Internal state of the function block as global copy of VAR\_OUTPUT

**eState:** For values see E\_S\_UPS\_State

## Requirements

Development environment	Target platform	Hardware	PLC libraries to be linked
TwinCAT v3.1	CX81xx	Seconds UPS	Tc2_SUPS

## 7.1.2 Data types

### E\_S\_UPS\_Mode

```
eSUPS_WrPersistData_Shutdown: Schreiben der persistenten Daten und dann QuickShutdown
eSUPS_WrPersistData_NoShutdown: Nur Schreiben der persistenten Daten (kein QuickShutdown)
eSUPS_ImmediateShutdown: Nur QuickShutdown (kein Schreiben der persistenten Daten)
eSUPS_CheckPowerStatus: Nur Status ermitteln (weder Schreiben der Persistenten Daten noch QuickShutdown)
```

### E\_S\_UPS\_State

```
eSUPS_PowerOK:
in allen Modi: Versorgungsspannung ist OK

eSUPS_PowerFailure:
in allen Modi: Versorgungsspannung fehlerhaft (steht nur einen Zyklus an)

eSUPS_WritePersistentData:
im Modus eSUPS_WrPersistData_Shutdown: Schreiben der persistenten Daten ist aktiv
im Modus eSUPS_WrPersistData_NoShutdown: Schreiben der persistenten Daten ist aktiv

eSUPS_QuickShutdown:
im Modus eSUPS_WrPersistData_Shutdown: QuickShutdown ist aktiv
im Modus eSUPS_ImmediateShutdown: QuickShutdown ist aktiv

eSUPS_WaitForRecover:
im Modus eSUPS_WrPersistData_NoShutdown: Warten auf Wiederkehr der Spannung
im Modus eSUPS_CheckPowerStatus: Warten auf Wiederkehr der Spannung

eSUPS_WaitForPowerOFF:
im Modus eSUPS_WrPersistData_Shutdown: Warten auf das Abschalten durch die USV
im Modus eSUPS_ImmediateShutdown: Warten auf das Abschalten durch die USV
```

### Requirements

Development environment	Target platform	Hardware	PLC libraries to be linked
TwinCAT v3.1	CX81xx	Seconds UPS	Tc2_SUPS

### 7.1.3 PlcAppSystemInfo

Each PLC contains an instance of type 'PlcAppSystemInfo' with the name '\_AppInfo'.

The corresponding namespace is 'TwinCAT\_SystemInfoVarList'. This must be specified for use in a library, for example.

```

TYPE PlcAppSystemInfo
STRUCT
  ObjId          : OTCID;
  TaskCnt        : UDINT;
  OnlineChangeCnt : UDINT;
  Flags          : DWORD;
  AdsPort        : UINT;
  BootDataLoaded : BOOL;
  OldBootData    : BOOL;
  AppTimestamp   : DT;
  KeepOutputsOnBP : BOOL;
  ShutdownInProgress : BOOL;
  LicensesPending : BOOL;
  BSODOccured    : BOOL;

  TComSrvPtr     : ITCOMObjectServer;

  AppName        : STRING(63);
  ProjectName    : STRING(63);
END_STRUCT
END_TYPE
    
```

<b>ObjId</b>	Object ID of the PLC project instance
<b>TaskCnt</b>	Number of tasks in the runtime system
<b>OnlineChangeCnt</b>	Number of online changes since the last complete download
<b>Flags</b>	Reserved
<b>AdsPort</b>	ADS port of the PLC application
<b>BootDataLoaded</b>	PERSISTENT variables: LOADED (without error)
<b>OldBootData</b>	PERSISTENT variables: INVALID (the back-up copy was loaded, since no valid file was present)
<b>AppTimestamp</b>	Time at which the PLC application was compiled
<b>KeepOutputsOnBP</b>	The flag can be set and prevents that the outputs are zeroed when a breakpoint is reached. In this case the task continues to run. Only the execution of the PLC code is interrupted.
<b>ShutdownInProgress</b>	This variable has the value TRUE if a shutdown of the TwinCAT system is in progress. Some parts of the TwinCAT system may already have been shut down.
<b>LicensesPending</b>	This variable has the value TRUE if not all licenses that are provided by license dongles have been validated yet.
<b>BSODOccured</b>	This variable has the value TRUE if Windows is in a BSOD.
<b>TComSrvPtr</b>	Pointer to the TcCOM object server
<b>AppName</b>	Name generated by TwinCAT, which contains the port.
<b>ProjectName</b>	Name of the project

## 7.2 Control diagnostic LEDs

### 7.2.1 Function F\_CX81x0\_LED\_WD

Since the CX8190 supports different protocols, the two LEDs WD and ERR on the CX8190 are not used by the firmware. This allows the user to create his own diagnosis messages. The LEDs can be used to indicate, for example, whether the CX8190 has received an IP address from the DHCP server or whether devices are exchanging data.



The function F\_CX8190\_LED\_WD controls the WD LED on the CX8190. Various color and flashing modes can be used here. The possible LED colors are red and green.

#### VAR\_INPUT

```
VAR_INPUT
    eMode      : E_CX81x0_LED;
END_VAR
```

eMode [▶ 50]: way in which the LED lights up.

#### VAR\_OUTPUT

```
F_CX8190_LED_WD      : INT;
```

F\_CX8190\_LED\_WD: -1, non-implemented flash code, 0 OK

#### Requirements

Development environment	Target platform	Hardware	PLC libraries to include
TwinCAT v3.1 Build 4022.30	ARM	CX8190	Tc2_SystemCX

### 7.2.2 Function F\_CX81x0\_LED\_ERR

Since the CX8190 supports different protocols, the two LEDs WD and ERR on the CX8190 are not used by the firmware. This allows the user to create his own diagnosis messages. The LEDs can be used to indicate, for example, whether the CX8190 has received an IP address from the DHCP server or whether devices are exchanging data.



The function F\_CX8190\_LED\_ERR controls the ERR LED on the CX8190. Various color and flashing modes can be used here. The possible LED colors are red and green.

#### VAR\_INPUT

```
VAR_INPUT
    eMode      : E_CX81x0_LED;
END_VAR
```

eMode [▶ 50]: way in which the LED lights up.

#### VAR\_OUTPUT

```
F_CX8190_LED_ERR      : INT;
```

F\_CX8190\_LED\_ERR: -1, non-implemented flash code, 0 OK

**Requirements**

Development environment	Target platform	Hardware	PLC libraries to include
TwinCAT v3.1 Build 4022.30	ARM	CX8190	Tc2_SystemCX

**7.2.3 Data type E\_CX81x0\_LED**

```

TYPE E_CX81x0_LED : (
  eCX81x0_LED_GREEN_OFF,
  eCX81x0_LED_GREEN_ON,
  eCX81x0_LED_GREEN_FLASHING_Quick,
  eCX81x0_LED_GREEN_FLASHING_200ms,
  eCX81x0_LED_GREEN_FLASHING_500ms,
  eCX81x0_LED_GREEN_FLASHING_Pulse,
  eCX81x0_LED_RED_OFF:=20,
  eCX81x0_LED_RED_ON,
  eCX81x0_LED_RED_FLASHING_Quick,
  eCX81x0_LED_RED_FLASHING_200ms,
  eCX81x0_LED_RED_FLASHING_500ms,
  eCX81x0_LED_RED_FLASHING_Pulse,
  eCX81x0_LED_GREEN_RED_OFF:=100,
  eCX81x0_LED_GREEN_RED_FLASHING_200ms,
  eCX81x0_LED_GREEN_RED_FLASHING_500ms
);
END_TYPE
    
```

**7.3 Function F\_CX81xx\_ADDRESS**

This function reads the position of the address selection switch of the CX8190. One possible application is that you can activate different program parts in the PLC depending on the switch position.



**VAR\_INPUT**

```

VAR_INPUT
  iCX_Typ      : INT;          (* Use product code without 'CX' e.g.: CX8180 -> 8180 *)
END_VAR
    
```

**VAR\_OUTPUT**

```

F_CX80xx_ADDRESS : INT;
    
```

**F\_CX80xx\_ADDRESS** : -1, non-implemented CX, address of the switch

**Requirements**

Development environment	Target platform	Hardware	PLC libraries to include
TwinCAT v3.1 Build 4022.30	ARM	CX8190	Tc2_SystemCX

**7.4 Real Time Clock (RTC)**

The RTC is read out via the FB\_LocalSystemTime function blocks and can be set with the NT\_SetLocalTime block (see TcUtilities.lib).

The RTC is supplied by the battery and can thus continue to run in the power-off state.

## 8 Ethernet X001 Interface

### 8.1 Ethernet

Ethernet was originally developed by DEC, Intel and XEROX (as the "DIX" standard) for passing data between office devices. The term nowadays generally refers to the *IEEE 802.3 CSMA/CD* specification, published in 1985. Because of the high acceptance around the world this technology is available everywhere and is very economical. This means that it is easy to make connections to existing networks.

There are now a number of quite different transmission media: coaxial cable (10Base5), optical fiber (10BaseF) or twisted pairs (10BaseT) with shield (STP) or without shield (UTP). Using Ethernet, different topologies can be built such as ring, line or star.

Ethernet transmits Ethernet packets from a sender to one or more receivers. This transmission takes place without acknowledgement, and without the repetition of lost packets. To achieve reliable data communication, there are protocols, such as TCP/IP, that can run on top of Ethernet.

#### MAC-ID

The sender and receiver of Ethernet packets are addressed by means of the MAC-ID. The MAC-ID is a 6-byte identification code unique to every Ethernet device in the world. The MAC-ID consists of two parts. The first part (i.e. the first 3 bytes) is a manufacturer identifier. The identifier for Beckhoff is 00 01 05. The next 3 bytes are assigned by the manufacturer and implement a unique serial number. The MAC-ID can, for example, be used for the BootP protocol in order to set the TCP/IP number. This involves sending a telegram containing the information such as the name or the TCP/IP number to the corresponding node. You can read the MAC-ID with the KS2000 configuration software.

#### The Internet Protocol (IP)

The internet protocol (IP) forms the basis of this data communication. IP transports data packets from one device to another; the devices can be in the same network, or in different networks. IP here looks after the address management (finding and assigning MAC-IDs), segmentation and routing. Like the Ethernet protocol, IP does not guarantee that the data is transported - data packets can be lost, or their sequence can be changed.

TCP/IP was developed to provide standardized, reliable data exchange between any numbers of different networks. TCP/IP was developed to provide standardized, reliable data exchange between any numbers of different networks. Although the term is often used as a single concept, a number of protocols are layered together here: e.g. IP, TCP, UDP, ARP and ICMP.

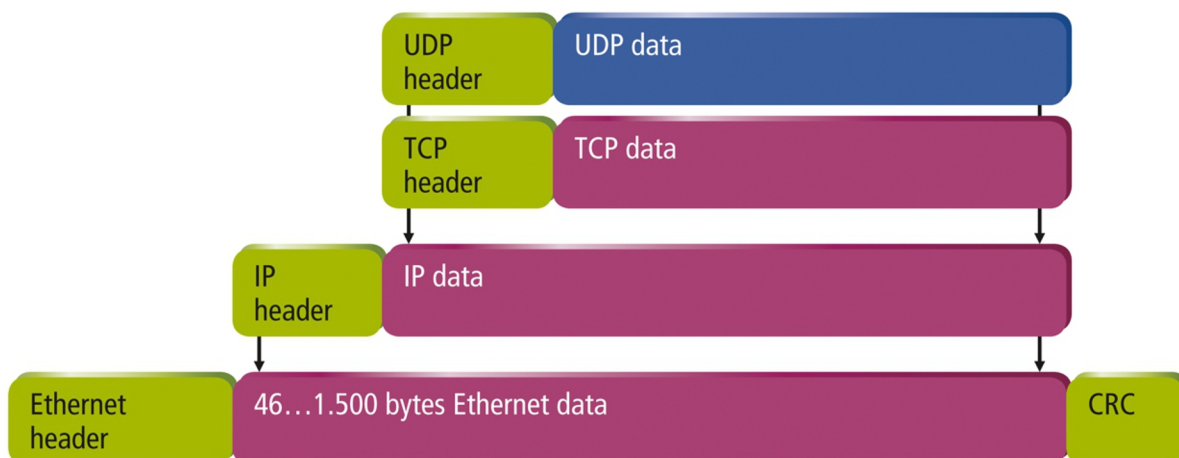


Fig. 13: Structure of the Ethernet protocol.

### Transmission Control Protocol (TCP)

The Transmission Control Protocol (TCP) which runs on top of IP is a connection-oriented transport protocol. It includes error detection and handling mechanisms. Lost telegrams are repeated.

### User Datagram Protocol (UDP)

UDP is connectionless transport protocol. It provides no control mechanism when exchanging data between sender and receiver. This results in a higher processing speed than, for example, TCP. Checking whether or not the telegram has arrived must be carried out by the higher-level protocol.

### Protocols running on top of TCP/IP and UDP/IP

The following protocols can run on top of TCP/IP or UDP/IP:

- ADS
- ModbusTCP

Both of these protocols are implemented in parallel on the Bus Coupler, so that no configuration is needed to activate the protocols.

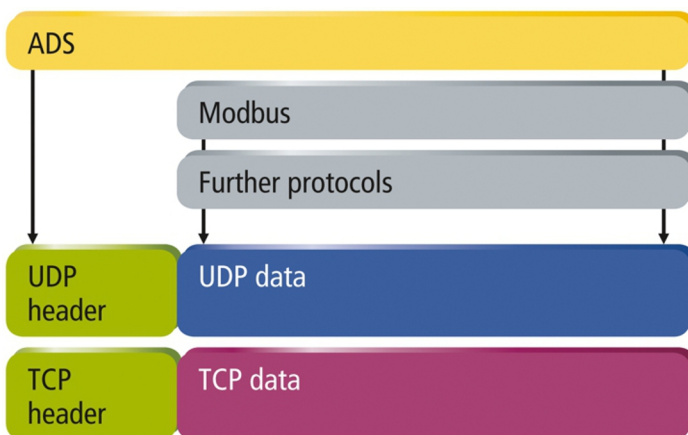


Fig. 14: Protocols running on top of TCP/IP and UDP/IP.

ADS can be used on top of either TCP or UDP, but ModbusTCP is always based on TCP/IP.



## 8.2 Topology example

Star wiring or a line topology is possible with the CX8190. Beckhoff recommends limiting the number of nodes to 10.

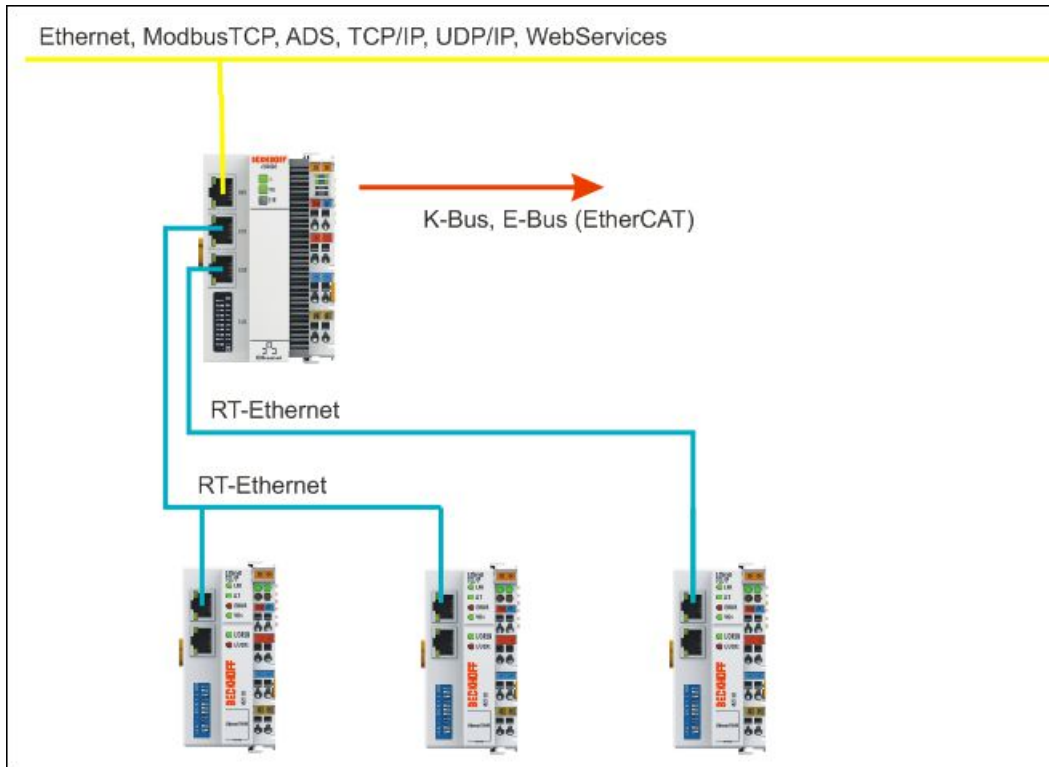


Fig. 15: Topology example: CX8190 connected to decentralized Bus Couplers via Realtime Ethernet.

## 8.3 ADS-Communication

The ADS protocol (ADS: Automation Device Specification) is a transport layer within the TwinCAT system. It was developed for data exchange between the different software modules, for instance the communication between the NC and the PLC. This protocol enables communication with other tools from any point within the TwinCAT. If it is necessary to communicate with another PC or device, the ADS protocol is used on top of TCP/IP. Within a networked system it is thus possible to reach all data from any point.

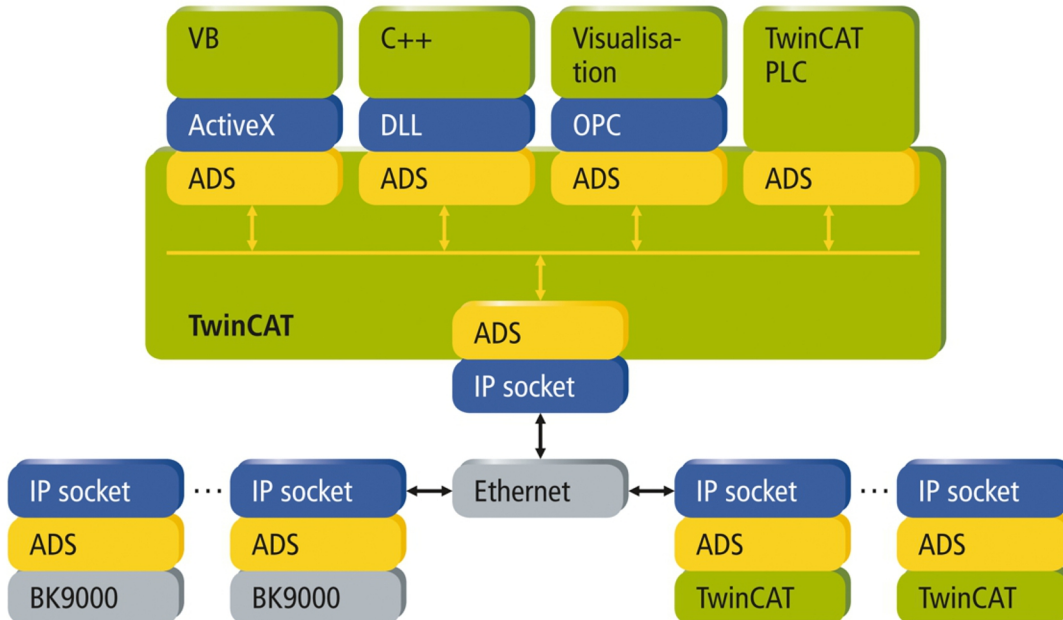


Fig. 16: The ADS protocol as a transport layer within TwinCAT.

The ADS protocol runs on top of the TCP/IP or UDP/IP protocols. It allows the user within the Beckhoff system to use almost any connecting route to communicate with all the connected devices and to parameterize them. Outside the Beckhoff system a variety of methods are available to exchange data with other software tools.

### Software interfaces

#### ADS-OCX

The ADS-OCX is an Active-X component. It offers a standard interface to, for instance, Visual Basic, Delphi, etc.

#### ADS-DLL

You can link the ADS-DLL (DLL: Dynamic Link Library) into your C program.

#### OPC

The OPC interface is a standardized interface for communication used in automation technology. Beckhoff offer an OPC server for this purpose.

### Protocol

The ADS functions provide a method for accessing the Bus Coupler information directly from the PC. ADS function blocks can be used in TwinCAT for this. The function blocks are contained in the *Tc2\_System.lib* library. It is also equally possible to call the ADS functions from AdsOCX, ADSDLL or OPC.

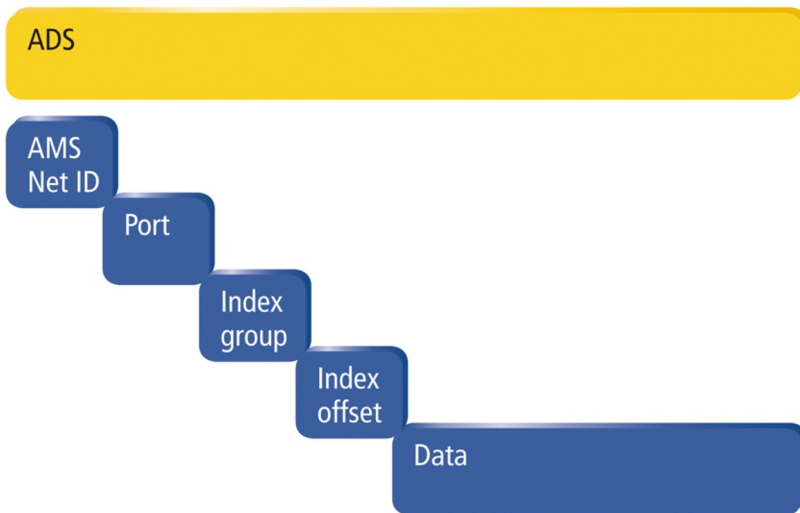


Fig. 17: Structure of the ADS communication.

### **AMSNID**

The AMSNetID provides a reference to the device that is to be addressed. This is taken from the MAC address of the first Ethernet port (X001) and is printed on the side of the CX80xx. For the AMSNetID the bytes 3..6 plus ".1.1" are typically used.

Example:

MAC address 00-01-05-01-02-03

AMSNID 5.1.2.3.1.1

### **Port number**

The port number distinguishes sub-elements in the connected device.

Port 851: local process data PLC runtime 1

### **Index group**

The index group distinguishes different data within a port.

### **Index offset**

Indicates the offset, from which reading or writing the byte is to start.

### **Len**

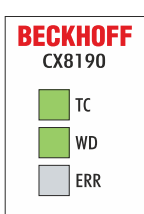
Gives the length of the data, in bytes, that is to be read or written.

### **TCP port number**

The TCP port number for the ADS protocol is 48898 or 0xBF02.

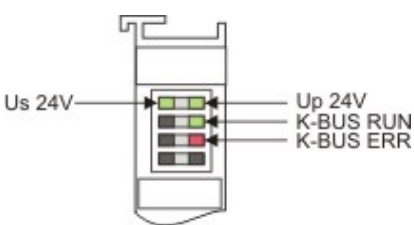
## 9 Error handling and diagnosis

### 9.1 Diagnostic LEDs

Display	LED	Meaning
	TC	TwinCAT Status LED: TwinCAT is in Run mode (green). TwinCAT is in Stop mode (red). TwinCAT is in Config mode (blue).
	WD	No function ex factory. The LED can be parameterized for user-specific diagnostic messages (see: F_CX8190_LED_WD function).
	ERR	Lights up red when switching on. Software is being loaded. Goes off if everything is OK.  The LED can be parameterized for user-specific diagnosis messages (see: F_CX8190_LED_ERR function).

### 9.2 Power supply terminal LEDs in K-bus mode

The power supply unit checks the connected Bus Terminals for errors. The red LED "K-bus ERR" is off if no error is present. The red LED "K-bus ERR" flashes if Bus Terminal errors are present.

Display	LED	Meaning
	Us 24 V	Power supply for basic CPU module. The LED lights green if the power supply is correct.
	Up 24V	Power supply for terminal bus. The LED lights green if the power supply is correct.
	K-BUS RUN	Diagnostic K-bus. The green LED lights up in order to indicate fault-free operation. "Error-free" means that the communication with the fieldbus system is also running.
	K-BUS ERR	Diagnostic K-bus. The red LED flashes to indicate an error. The red LED blinks with two different frequencies.

The frequency and number of the flashes can be used to determine the error code and the error argument. An error is indicated by the "K-bus ERR" LED in a particular order.

Table 12: K-bus ERR LED, fault indication sequence through the LED.

Order	Meaning
Fast blinking	Starting the sequence
<b>First slow sequence</b>	<b>Error code</b>
No display	Pause, the LED is off
<b>Second slow sequence</b>	<b>Error code argument</b>

Count how often the red LED K-bus ERR flashes, in order to determine the error code and the error argument. In the error argument the number of pulses shows the position of the last Bus Terminal before the error. Passive Bus Terminals, such as a power feed terminal, are not included in the count.

Table 13: K-BUS ERR LED, fault description and troubleshooting.

Error code	Error code argument	Description	Remedy
Persistent, continuous flashing		EMC problems.	<ul style="list-style-type: none"> <li>• Check power supply for undervoltage or overvoltage peaks.</li> <li>• Implement EMC measures.</li> <li>• If a K-bus error is present, it can be localized by a restart of the power supply (by switching it off and then on again)</li> </ul>
3 pulses	0	K-bus command error.	<ul style="list-style-type: none"> <li>• No Bus Terminal inserted.</li> <li>• One of the Bus Terminals is defective; halve the number of Bus Terminals attached and check whether the error is still present with the remaining Bus Terminals. Repeat this procedure until the faulty Bus Terminal has been found.</li> </ul>
4 pulses	0	K-bus data error, break behind the power supply unit.	Check whether the Bus End Terminal 9010 is connected.
	n	Break behind Bus Terminal n	Check whether Bus Terminal n+1 after the power supply unit is connected correctly; replace if necessary.
5 pulses	n	K-bus error in register communication with Bus Terminal n.	Replace Bus Terminal at location n.
6 pulses	0	Error at initialization.	Replace Embedded PC.
	1	Internal data error.	Hardware reset of the Embedded PC (switch off and back on again).
	8	Internal data error.	Hardware reset of the Embedded PC (switch off and back on again).
7 pulses	0	Process data lengths of the set and actual configurations do not correspond.	Check the configuration and the Bus Terminals for consistency.

For some error the LED "K-BUS ERR" does not go out, even if the error was rectified. Switch the power supply for the power supply unit off and back on again to switch off the LED after the error has been rectified.

**State variable**

In TwinCAT there is a State variable under the Bus Coupler for K-bus diagnostics.

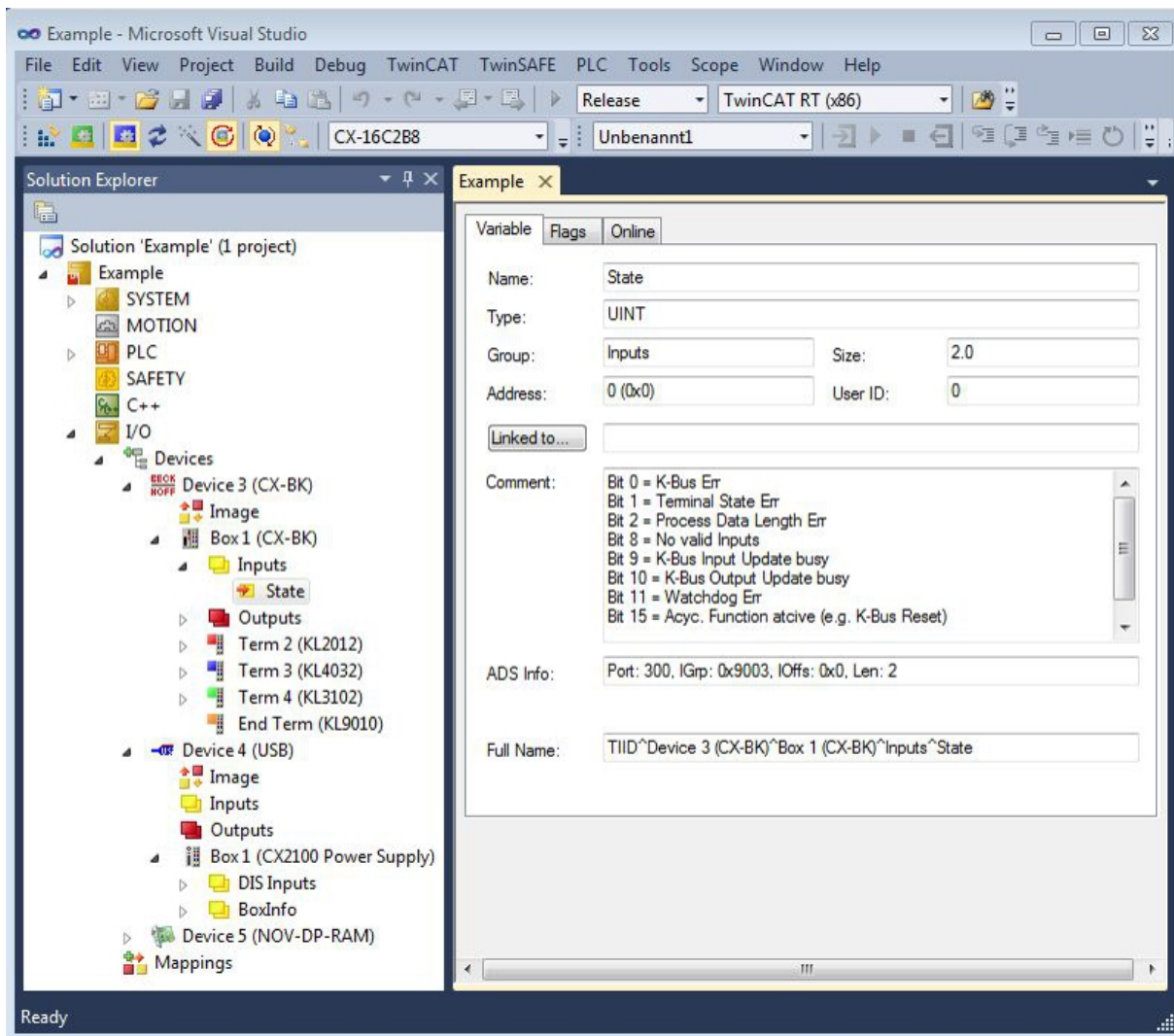


Fig. 18: Status variable for error handling and diagnostics under TwinCAT.

If the value is "0", the K-bus operates synchronous and without error. If the value is  $\neq$  "0" there may be a fault, or it may only be an indication that the K-bus cycle is longer than the task. In which case it would no longer be synchronous with the task. The task time should be faster than 100 ms. We recommend a task time of less than 50 ms. The K-bus update time typically lies between one and five ms.

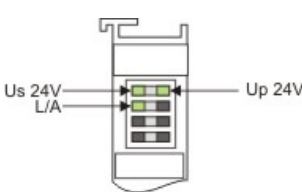
Table 14: Description of the State variable values.

Bit	Description
Bit 0	K-bus error.
Bit 1	Terminal configuration has changed since the start.
Bit 2	Process image lengths do not match.
Bit 8	(still) no valid inputs.
Bit 9	K-bus input update not yet complete.
Bit 10	K-bus output update not yet complete.
Bit 11	Watchdog.
Bit 15	Acyclic K-bus function active (e.g. K-bus reset).

If there is a K-bus error, this can be reset via the IOF\_DeviceReset function block (in the TcIoFunctions.lib).

### 9.3 Power supply terminal LEDs in E-bus mode

The power supply unit checks the connected EtherCAT Terminals. The "L/A" LED is lit in E-bus mode. The "L/A" LED flashes during data transfer.

Display	LED		Meaning
	Us 24 V		Power supply for basic CPU module. The LED lights green if the power supply is correct.
	Up 24 V		Power supply for terminal bus. The LED lights green if the power supply is correct.
	L / A	off	E-bus not connected.
		on	E-bus connected / no data traffic.
	flashes	E-bus connected / data traffic on the E-bus.	

## 10 Care and maintenance

### 10.1 Replace the battery

#### NOTE

##### Risk of explosion

An incorrectly inserted battery may explode and damage the Embedded PC.

Only use original batteries and ensure that the positive and negative poles are inserted correctly.

The battery must be replaced every 5 years. Spare batteries can be ordered from Beckhoff Service. A battery of type CR2032 from Sanyo or Panasonic is used for the Embedded PC.

Table 15: Technical data of the battery.

Battery type	Electrical properties (at 20 °C)		Standard load	Dimensions		
	nominal voltage	nominal capacity		continuous load	Diameter	Height
CR2032	3.0 V	225 mAh	0.20 mA	20.0 mm	3.20 mm	3.1 g

The battery compartment is below the front flap. The battery stores the time and date. The time and date are reset if the battery is removed.

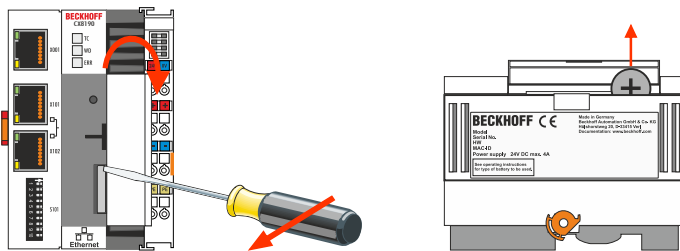
Be aware of this behavior for your hardware and software configuration and reset the time and date after a battery change.

Requirements:

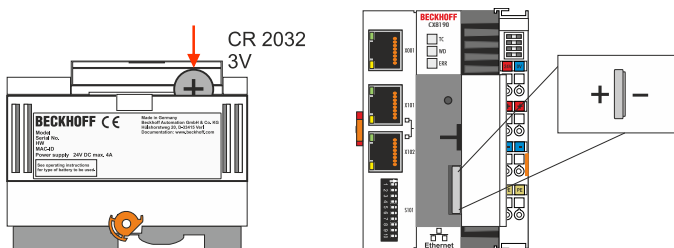
- The Embedded PC is switched off.

Replace the battery as follows:

1. Open the front flap.
2. Apply the screwdriver below or above the battery and prize the battery carefully out of the battery compartment.



3. Push the new battery into the battery compartment. The plus pole points to the left towards the Ethernet interfaces.



⇒ The battery change is complete. Close the front flap and reset the date and time.



# 11 Technical data

Table 16: Technical data, dimensions and weights.

	<b>CX8190</b>
Dimensions (W x H x D)	71 mm x 100 mm x 73 mm
Weight	230 g

Table 17: Technical data, general data.

<b>Technical data</b>	<b>CX8190</b>
Processor	ARM Cortex™-A9, 800 MHz 32-bit
Main memory	512 MB DDR3-RAM
Flash memory	MicroSD card (ATP) 512 MB (optionally 1, 2, 4, 8 GB)
Interfaces	1 x RJ45 10/100 MBit/s
Bus interface	2 x RJ45 (switched)
Protocol	Real-time Ethernet, ADS UDP, ADS TCP, EAP (EtherCAT Automation Protocol)
Persistent memory	1-second UPS integrated
Power supply	24 V <sub>DC</sub> (-15 %/+20 %)
max. power loss	4 W (including system interfaces)
Dielectric strength	500 V (supply / internal electronics)
Operating system	Microsoft Windows Embedded Compact 7
Control software	TwinCAT 3, licenses not included
Diagnostic LED	1 x TC Status, 1 x WD LED, 1 x ERR LED
Clock	internal battery-backed clock (RTC) for time and date (battery exchangeable)
Approvals	CE, UL

Table 18: Technical data, I/O terminals.

<b>Technical data</b>	<b>CX8190</b>
I/O connection	via power supply terminal (E-bus or K-bus, automatic recognition)
Power supply for I/O terminals	max. 2 A
Power contacts current loading	max. 10 A
Process data on the K-bus	max. 2 KB in and 2 KB out
max. number of terminals (K-bus)	64 (255 with K-bus extension)
max. number of terminals (E-bus)	up to 65534 terminals.

Table 19: Technical data, environmental conditions.

<b>Technical data</b>	<b>CX8190</b>
Ambient temperature during operation	-25 °C ... +60 °C
Ambient temperature during storage	-40 °C ... +85 °C see notes under: <a href="#">Transport and storage</a> [▶ 10]
Relative humidity	95% no condensation
Vibration resistance	conforms to EN 60068-2-6
Shock resistance	conforms to EN 60068-2-27
EMC immunity	conforms to EN 61000-6-2
EMC emission	conforms to EN 61000-6-4
Protection class	IP20

*Table 20: Technical data, Ethernet interface X001.*

<b>Technical data</b>	<b>Description</b>
Data transfer medium	4 x 2 twisted pair copper cables category 5 (100 MBit/s)
Cable length	100 m from switch to CX8190
Data transfer rate	10/100 MBit/s
Topology	star wiring
Protocols	all non-real-time-capable protocols that are based on TCP or UDP and require no real-time extension

*Table 21: Technical data, Ethernet interfaces X101/X102.*

<b>Technical data</b>	<b>Description</b>
Data transfer medium	4 x 2 twisted pair copper cables category 5 (100 MBit/s)
Cable length	100 m from switch to CX8190
Data transfer rate	100 Mbit/s
Topology	star wiring, line topology
Protocols (real-time)	RT-Ethernet, EAP (publisher/subscriber)
Protocols (non-real-time)	all non-real-time-capable protocols that are based on TCP or UDP and require no real-time extension

## **12 Appendix**

### **12.1 Certification**

#### **12.1.1 FCC**

##### **FCC Approvals for the United States of America**

##### **FCC: Federal Communications Commission Radio Frequency Interference Statement**

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

##### **FCC Approval for Canada**

##### **FCC: Canadian Notice**

This equipment does not exceed the Class A limits for radiated emissions as described in the Radio Interference Regulations of the Canadian Department of Communications.

## 12.2 Support and Service

Beckhoff and their partners around the world offer comprehensive support and service, making available fast and competent assistance with all questions related to Beckhoff products and system solutions.

### Beckhoff's branch offices and representatives

Please contact your Beckhoff branch office or representative for local support and service on Beckhoff products!

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You will also find further documentation for Beckhoff components there.

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