

Manual | EN

# CX5110-01xx-9020

Embedded PC





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# 1 Notes on the documentation

This description is intended exclusively for trained specialists in control and automation technology who are familiar with the applicable national standards.

For installation and commissioning of the components, it is absolutely necessary to comply with the documentation and the following notes and explanations.

The qualified personnel is always obliged to use the currently valid documentation.

The responsible staff must ensure that the application or use of the products described satisfies all safety requirements, 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 notice.

No claims to modify 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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## Patents

The EtherCAT Technology is covered by the following patent applications and patents, without this constituting an exhaustive list:

EP1590927, EP1789857, EP1456722, EP2137893, DE102015105702

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## 1.1 Representation and structure of warnings

The following warnings are used in the documentation. Read and follow the warnings.

### Warnings relating to personal injury:

 **DANGER**

Hazard with high risk of death or serious injury.

 **WARNING**

Hazard with medium risk of death or serious injury.

 **CAUTION**

There is a low-risk hazard that can result in minor injury.

### Warnings relating to damage to property or the environment:

**NOTICE**

There is a potential hazard to the environment and equipment.

### Notes showing further information or tips:



This notice provides important information that will be of assistance in dealing with the product or software. There is no immediate danger to product, people or environment.

## 1.2 Documentation issue status

| Version | Modifications                    |
|---------|----------------------------------|
| 1.0     | First release                    |
| 1.1     | N020 interface is not supported. |

## 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.
- Use of untrained personnel.
- Use of unauthorized replacement parts.

### 2.1 Intended use

The embedded PC is a control system for use in machine and system engineering for automation, visualization and communication. The embedded PC is designed for installation in a control cabinet or terminal box and is used together with Bus or EtherCAT Terminals to receive digital and analog signals from sensors and output them to actuators or forward them to 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. If the devices are to be used 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 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 Industrial 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 connection.
- 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

- Restrict access to all devices to an authorized circle of persons.
- Change the default passwords to reduce the risk of unauthorized access.
- Protect the devices with 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

- The sensitivity of a PC against malicious software increases with the number of installed and active software.
- Uninstall or disable unnecessary software.

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

<http://infosys.beckhoff.com>

| Document name          |
|------------------------|
| IPC Security Guideline |

## 2.4 Notes on information security

The products of Beckhoff Automation GmbH & Co. KG (Beckhoff), insofar as they can be accessed online, are equipped with security functions that support the secure operation of plants, systems, machines and networks. Despite the security functions, the creation, implementation and constant updating of a holistic security concept for the operation are necessary to protect the respective plant, system, machine and networks against cyber threats. The products sold by Beckhoff are only part of the overall security concept. The customer is responsible for preventing unauthorized access by third parties to its equipment, systems, machines and networks. The latter should be connected to the corporate network or the Internet only if appropriate protective measures have been set up.

In addition, the recommendations from Beckhoff regarding appropriate protective measures should be observed. Further information regarding information security and industrial security can be found [here](#).

Beckhoff products and solutions undergo continuous further development. This also applies to security functions. In light of this continuous further development, Beckhoff expressly recommends that the products are kept up to date at all times and that updates are installed for the products once they have been made available. Using outdated or unsupported product versions can increase the risk of cyber threats.

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### 3 Transport and storage

#### Transport

#### NOTICE

##### 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

- high mechanical stress and
- use the original packaging for shipping.

*Table 1: Dimensions and weight.*

|                        | <b>CX5110-01xx-9020</b> |
|------------------------|-------------------------|
| Dimensions (W x H x D) | 102 mm x 100 mm x 92 mm |
| Weight                 | approx. 760 g           |

#### Storage

- Remove the battery from the Embedded PC if storage temperatures exceed 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.

## 4 Product overview

The CX5110-01xx-9020 is a suitable, functional and economical replacement version of the CX9020. The CX5110-01xx-9020 has an Intel Atom® single core processor with 1.20 GHz. The processor clocks at 1.20 GHz instead of 1.46 GHz to realize lower power consumption and thus a reduced housing width.

The Embedded PC is functionally compatible with the CX9020, but not image compatible. Use the standard image supplied with the CX5110-01xx-9020 and copy your existing TwinCAT project to the CX5110-01xx-9020 if required. Note that the TwinCAT project must be recompiled after copying to the CX5110-01xx-9020.

The CX5110-01xx-9020 Embedded PC is a full-fledged PC with the following basic configuration:

- CFast card slot,
- MicroSD card slot,
- two independent Gbit Ethernet interfaces,
- four USB 2.0 interfaces,
- and a DVI-I interface.

The operating system is Windows Embedded Compact 7.

The CX5110-01xx-9020 has 128 kB NOVDRAM as persistent data memory by default. In addition, the embedded PC can be ordered ex factory with a capacitive 1-second UPS. In the event of a power failure the 1-second UPS can store up to 1 MB of persistent data on the CFast card or MicroSD card.

The embedded PC can be ordered ex factory with an optional interface. The optional interface cannot be retrofitted.

*Table 2: Available optional interfaces for the CX5110-01xx-9020.*

| <b>CX5110-01xx-9020</b> | <b>Optional interfaces</b>                        |
|-------------------------|---|
| CX5110-N030             | RS232, D-sub connector, 9-pin.                    |
| CX5110-N031             | RS422/RS485, D-sub socket, 9-pin.                 |
| CX5110-B110             | EtherCAT slave, EtherCAT IN and OUT (2 x RJ45).   |
| CX5110-M310             | PROFIBUS master, D-sub socket, 9-pin.             |
| CX5110-B310             | PROFIBUS slave, D-sub socket, 9-pin.              |
| CX5110-M510             | CANopen master, D-sub connector, 9-pin.           |
| CX5110-B510             | CANopen slave, D-sub connector, 9-pin.            |
| CX5110-M930             | PROFINET RT, controller, Ethernet (2 x RJ-45).    |
| CX5110-B930             | PROFINET RT, device, Ethernet (2 x RJ-45 switch). |

### 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).

### Software

In combination with the TwinCAT automation software the CX5110-01xx-9020 Embedded PC becomes a powerful IEC 61131-3 PLC.

Depending on the installed TwinCAT runtime environment, the CX5110-01xx-9020 can be used for the implementation of PLC or PLC/Motion Control projects (with or without visualization).

## 4.1 Structure

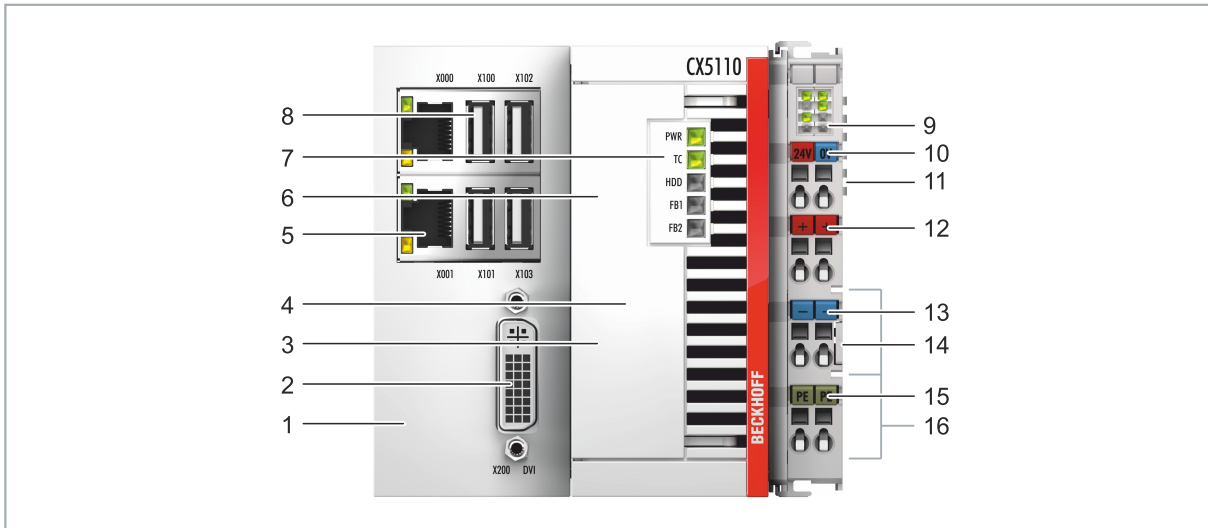


Fig. 1: Example: CX5110-01xx-9020 Embedded PC.

Table 3: Key for the configuration.

| No. | Component  | Description   |
|-----|--|---|
| 1   | Optional interface (X300) [▶ 20].                  | Space for interfaces such as RS232, EtherCAT, CANopen or others. The optional interface must be pre-ordered ex factory and cannot be retrofitted. |
| 2   | DVI-I interface (X200) [▶ 19].                     | Interface for a monitor or panel.   |
| 3   | CFast card slot [▶ 30] (under the front flap).     | Slot for industrial CFast cards.  |
| 4   | MicroSD card slot [▶ 29] (under the front flap).   | Slot for industrial MicroSD cards.  |
| 5   | RJ45 Ethernet interfaces (X000, X001) [▶ 18].      | For connecting to local networks or the internet.   |
| 6   | Battery compartment [▶ 68] (under the front flap). | Power supply for the battery-backed clock for time and date.  |
| 7   | Diagnostic LEDs [▶ 63].                            | Diagnostic LEDs for power supply, TwinCAT and the optional interface.   |
| 8   | USB interfaces (X100, X101, X102, X103) [▶ 17].    | Interfaces for peripheral devices such as mouse, keyboard or USB memory.  |
| 9   | Diagnostic LEDs, power supply terminal [▶ 63].     | Diagnosis of the power supply for the embedded PC and the terminal bus. Status of the E-bus and K-bus communication.                              |
| 10  | Spring-loaded terminals, +24 V and 0 V             | Power supply for embedded PC.   |
| 11  | Terminal bus (K-bus or E-bus)                      | Interface for EtherCAT Terminals or bus terminals. Data exchange and supply.  |
| 12  | Spring-loaded terminal, +24 V                      | Power supply for bus terminals via power contact.   |
| 13  | Spring-loaded terminal, 0 V                        | Power supply for bus terminals via power contact.   |
| 14  | Terminal release                                   | Releases the power supply terminal and therefore the embedded PC from the mounting rail.  |
| 15  | Spring-loaded terminal, PE                         | Spring-loaded terminal for power contact PE.  |
| 16  | Power contacts, +24 V, 0 V, PE                     | Power contacts for bus terminals.   |

## 4.2 Name plate

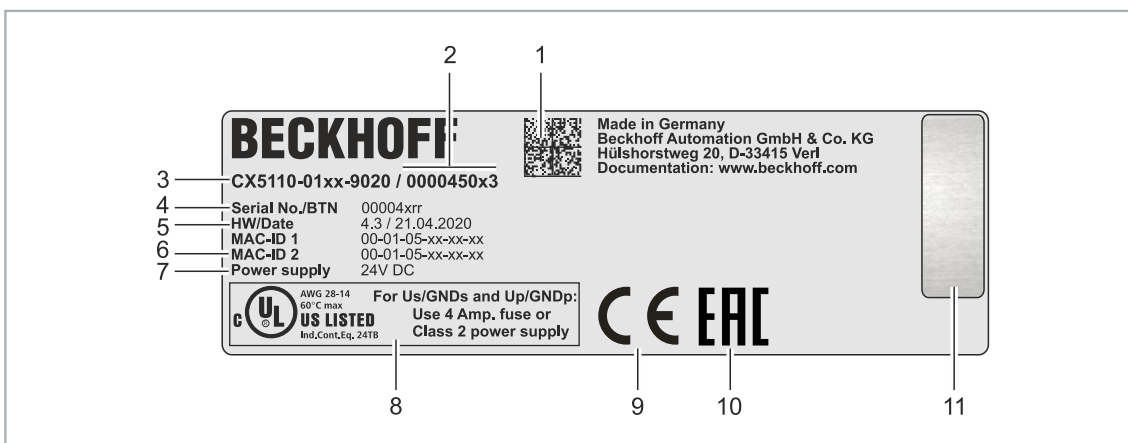


Fig. 2: Name plate example.

*Table 4: Information on the name plate.*

| No. | Description  |
|-----|--|
| 1   | Machine-readable information in the form of a Data Matrix Code (DMC, code scheme ECC200) that you can use for better identification and management.  |
| 2   | Variant number for identification of the Embedded PC configuration. With this number, the exact configuration of Embedded PC, operating system, options and TwinCAT can be reordered.                                  |
| 3   | Product designation for identification of the Embedded PC.   |
| 4   | Serial number/ Beckhoff Traceability Number (BTN) for the unambiguous identification of the product.   |
| 5   | Hardware version and date of manufacture.  |
| 6   | MAC addresses of the built-in Ethernet interfaces. The host name is made up of CX and the last three bytes of the MAC address. Example: the MAC address: 00-01-05-aa-bb-cc results in the host name <b>CX-aabbcc</b> . |
| 7   | Power supply 24 V DC   |
| 8   | UL marking with prescribed information on power supply, fuse, temperature and cable cross-sections.  |
| 9   | EAC marking  |
| 10  | CE marking   |
| 11  | License sticker for operating system (optional).   |

### 4.3 Types

The CX5110-01xx-9020 Embedded PC can be ordered with different software options. Use this overview in conjunction with the information on the name plate to ascertain the operating system and the TwinCAT version of the embedded PC.

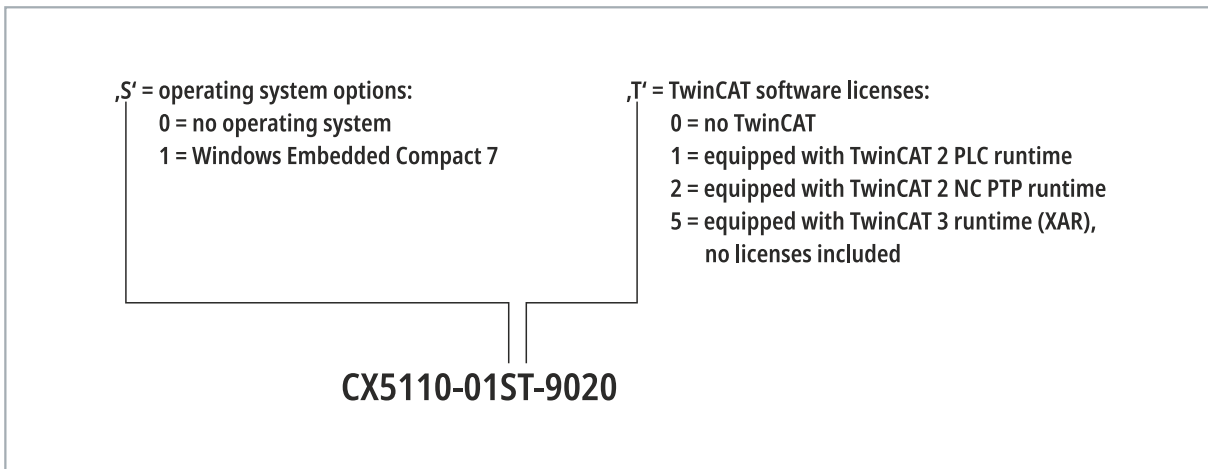


Fig. 3: Nomenclature for the CX5110-01xx-9020 Embedded PC.

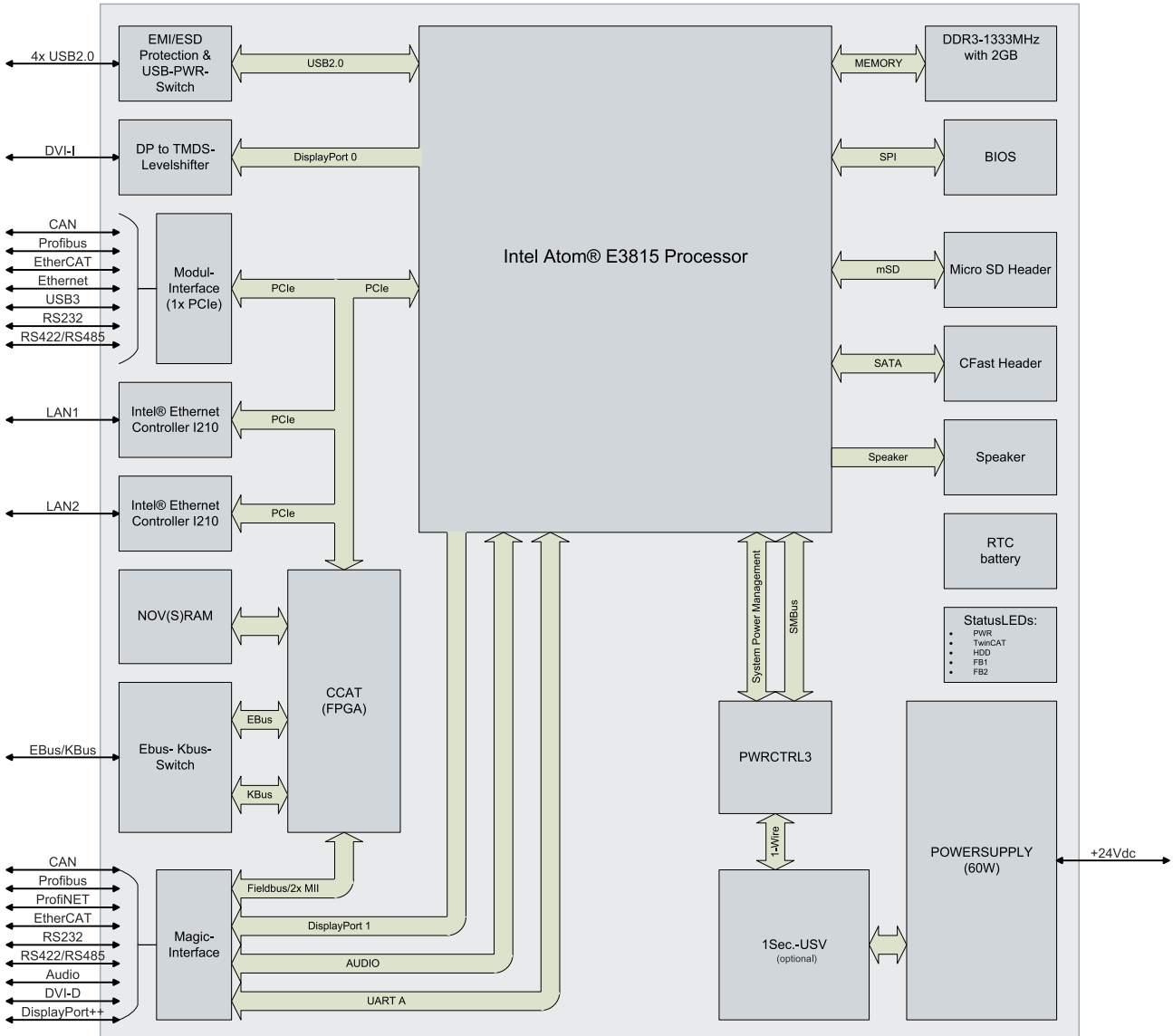
The CX5110-01xx-9020 Embedded PC is available with the following software options:

Table 5: CX5110-01xx-9020, ordering information for software.

| Ordering information | Description  |
|----------------------|--|
| CX5110-0100-9020     | no operating system, no TwinCAT                      |
| CX5110-0110-9020     | Windows Embedded Compact 7, no TwinCAT               |
| CX5110-0111-9020     | Windows Embedded Compact 7, TwinCAT 2 PLC runtime    |
| CX5110-0112-9020     | Windows Embedded Compact 7, TwinCAT 2 NC PTP runtime |
| CX5110-0115-9020     | Windows Embedded Compact 7, TwinCAT 3 runtime (XAR)  |

TwinCAT 3 runtime (XAR) is pre-installed, without licenses. Please refer to the TwinCAT 3 price list for the TwinCAT 3 licenses to be ordered separately.

## 4.4 Architecture overview



The CX5110-01xx-9020 Embedded PC is based on the Intel Atom microarchitecture, which was developed by Intel. The following CPU is used:

- Intel® Atom™ E3815

In addition to the arithmetic unit, the CPU also contains the memory controller and the graphics controller. The processors use the Intel® HD Graphics core. For details on the CPU please refer to Intel. The main memory is directly connected to the CPU. The embedded PC is equipped with 2 GB DDR3 RAM and is not expandable.

The CPU provides all required interfaces:

- 1 PCIe lane for each of the two Intel® i210 Gigabit Ethernet controllers
- 4x USB 2.0 (interfaces)
- DVI-I interface
- 1 PCIe for FPGA for K-/E-bus
- 1 SATA for CFast card interface
- 1 IDE for MicroSD card interface

The interfaces (USB, DVI, and LAN) are standard interfaces. Devices that meet the corresponding standard can be connected to and operated at these interfaces.



## 5 Interface description

### 5.1 USB (X100, X101, X102, X103)

The Embedded PC has four independent USB interfaces for connecting keyboards, mice, touchscreens and other input or data storage devices.

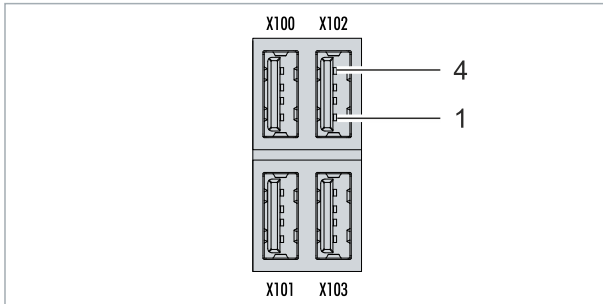


Fig. 4: USB interfaces (X100, X101, X102, X103).

The USB interfaces are type A and comply with the USB 2.0 specification.

Table 6: USB interfaces (X100, X101, X102, X103), pin assignment.

| Pin   | Connection | Typical assignment |
|-------|------------|--------------------|
| 1     | VBUS       | Red                |
| 2     | D-         | White              |
| 3     | D+         | Green              |
| 4     | GND        | Black              |
| Shell | Shield     | Drain Wire         |

Note the power consumption of the individual devices. Each interface is limited to 500 mA.

## 5.2 Ethernet RJ45 (X000, X001)

The two Ethernet interfaces are independent; no switch is integrated. The independent Ethernet interfaces can be configured in different ways. In the delivery state, the Ethernet interfaces (X000, X001) are configured for EtherCAT communication.

Note that an additional switch is required for a line topology.

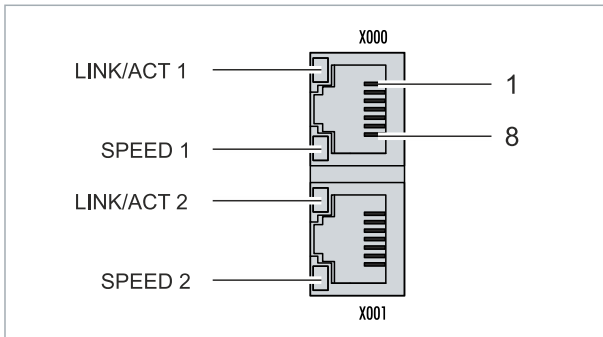


Fig. 5: Ethernet interfaces X000, X001.

Both Ethernet interfaces reach speeds of 10 / 100 / 1000 Mbit. The LEDs on the left of the interfaces indicate the connection status. The upper LED (LINK/ACT) indicates whether the interface is connected to a network. If this is the case, the LED lights up green. The LED flashes when data transfer on the interface is in progress.

The lower LED (SPEED) indicates the connection speed. At a speed of 10 Mbit, the LED does not light up. If the speed is 100 Mbit, the LED lights up green. The LED lights up red if the speed is 1000 Mbit (gigabit).

Table 7: Ethernet interface X000 and X001, pin assignment.

| PIN | Signal | Description |
|-----|--------|-------------|
| 1   | T2 +   | Pair 2      |
| 2   | T2 -   |             |
| 3   | T3 +   | Pair 3      |
| 4   | T1 +   | Pair 1      |
| 5   | T1 -   |             |
| 6   | T3 -   | Pair 3      |
| 7   | T4 +   | Pair 4      |
| 8   | T4 -   |             |

### 5.3 DVI-I (X200)

The DVI-I interface (X200) transfers digital data and is suitable for connection to digital or analog monitors. The resolution on the display or the Beckhoff Control Panel depends on the distance from the display device. The maximum distance is 5 m. Beckhoff offers various panels with an integrated DVI extension. A cable length of up to 50 meters is therefore possible.

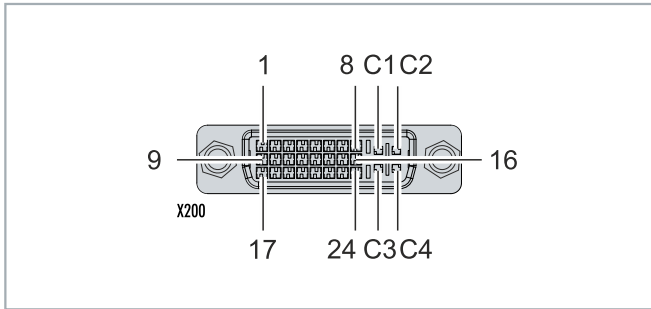


Fig. 6: DVI-I interface X200.

Table 8: DVI-I interface X200, pin assignment.

| Pin | Connection           | Pin | Connection                      | Pin | Connection           |
|-----|----------------------|-----|---------------------------------|-----|----------------------|
| 1   | TMDS Data 2-         | 9   | TMDS Data 1-                    | 17  | TMDS Data 0-         |
| 2   | TMDS Data 2+         | 10  | TMDS Data 1+                    | 18  | TMDS Data 0+         |
| 3   | TMDS Data 2/4 Shield | 11  | TMDS Data 1/3 Shield            | 19  | TMDS Data 0/5 Shield |
| 4   | not connected        | 12  | not connected                   | 20  | not connected        |
| 5   | not connected        | 13  | not connected                   | 21  | not connected        |
| 6   | DDC Clock            | 14  | + 5V Power                      | 22  | TMDS Clock Shield    |
| 7   | DDC Data             | 15  | Ground ( +5V, Analog H/ V Sync) | 23  | TMDS Clock +         |
| 8   | Analog Vertical Sync | 16  | Hot Plug Detect                 | 24  | TMDS Clock -         |

Table 9: DVI-I cross, pin assignment.

| Pin | Connection             |
|-----|------------------------|
| C1  | Analog Red Video Out   |
| C2  | Analog Green Video Out |
| C3  | Analog Blue Video Out  |
| C4  | Analog Horizontal Sync |

Table 10: DVI-I interface X200, resolution at the monitor.

| Resolution in pixels | Distance of the interface from the monitor |
|----------------------|--|
| 1920 x 1200          | 5 m  |
| 1920 x 1080          | 5 m  |
| 1600 x 1200          | 5 m  |
| 1280 x 1024          | 5 m  |
| 1024 x 768           | 5 m  |
| 800 x 600            | 5 m  |
| 640 x 480            | 5 m  |

The embedded PC also supports higher resolutions, based on the DVI standard. A maximum resolution of 1920 x 1200 pixels can be set on the embedded PC. Whether this resolution is achieved depends on the monitor, the cable quality, and the cable length.

## 5.4 Optional interfaces

An optional interface is an additional interface that can be equipped with a wide range of signal types ex factory and extends the Embedded PC beyond the basic equipment. The optional interface must be ordered in advance and cannot be retrofitted to the device.

### 5.4.1 RS232 (N030)

The optional N030 interface provides an RS232 interface (X300). The RS232 interface is implemented on a 9-pin D-sub connector.

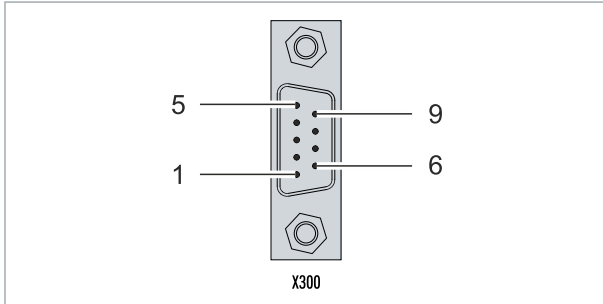


Fig. 7: RS232 interface X300.

The maximum baud rate on both channels is 115 kbit. The interface parameters are set via the operating system or from the PLC program.

Table 11: RS232 interface X300, pin assignment.

| PIN | Signal | Type       | Description     |
|-----|--------|------------|-----------------|
| 1   | -      | -          | -               |
| 2   | RxD    | Signal in  | Receive Data    |
| 3   | TxD    | Signal out | Transmit Data   |
| 4   | -      | -          | -               |
| 5   | GND    | Ground     | Ground          |
| 6   | -      | -          | -               |
| 7   | RTS    | Signal out | Request to Send |
| 8   | CTS    | Signal in  | Clear to Send   |
| 9   | -      | -          | -               |

#### Limited driver support

The driver manufacturer does not support all standard functions for the interface. As a result, some applications may not run properly under Windows.

The following API and IOCTLs are not supported:

- SetupComm
- SetCommBreak
- ClearCommBreak
- EscapeCommFunction (no support for parameters SETBREAK and CLR-BREAK)
  
- IOCTL\_SERIAL\_XOFF\_COUNTER
- IOCTL\_SERIAL\_LSRMST\_INSERT
- IOCTL\_SERIAL\_SET\_BREAK\_ON
- IOCTL\_SERIAL\_SET\_BREAK\_OFF

### 5.4.2 RS422/RS485 (N031)

The optional N031 interface provides an RS422 or RS485 interface (X300). The interface is executed on a 9-pin D-sub socket.

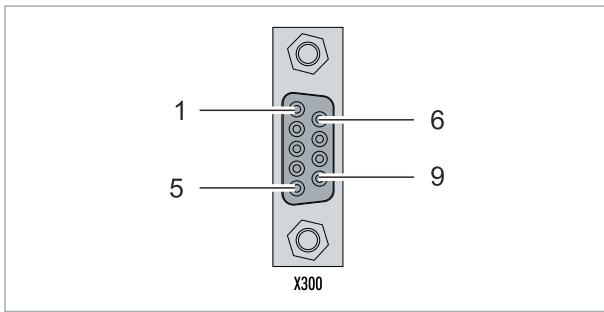


Fig. 8: RS485 interface X300.

The maximum baud rate on both channels is 115 kbit. The interface parameters are set via the operating system or from the PLC program.

Table 12: RS422/485 interface, pin assignment.

| PIN | Signal | Type       | Description  |
|-----|--------|------------|--------------|
| 2   | TxD+   | Data-Out + | Transmit 422 |
| 3   | RxD+   | Data-In +  | Receive 422  |
| 5   | GND    | Ground     | Ground       |
| 6   | VCC    | VCC        | +5 V         |
| 7   | TxD-   | Data-Out - | Transmit 422 |
| 8   | RxD-   | Data-In -  | Receive 422  |

For RS 485 pins 2 and 3 (data +) must be connected, and pins 7 and 8 (data -).

By default the interface is parameterized as follows on delivery:

Table 13: Default setting, RS485 without echo with end point (terminated).

| Function          | Status |
|-------------------|--------|
| Echo on           | off    |
| Echo off          | on     |
| Auto send on      | on     |
| Always send on    | off    |
| Auto receive on   | on     |
| Always receive on | off    |
| Term on           | on     |
| Term on           | On     |

#### Other configurations for the RS485 interface

Other configurations for the RS485 interface can be ordered ex factory. The following options are available:

- N031-0001 RS485 with echo, end point (terminated).
- N031-0002 RS485 without echo, stub (without termination).
- N031-0003 RS485 with echo, stub (without termination).
- N031-0004 RS422 full duplex end point (terminated).

An RS485 interface cannot be configured retrospectively and must always be ordered ex factory as required.

### 5.4.3 EtherCAT slave (B110)

The latest generation of Embedded PCs can be ordered ex factory with an EtherCAT slave interface (B110). On the devices the optional B110 interface is referred to as X300.

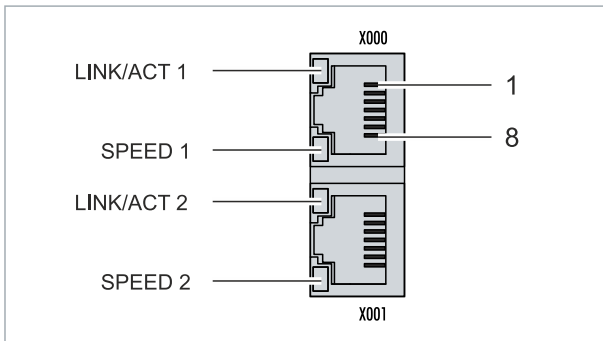


Fig. 9: EtherCAT slave interface X300.

The incoming EtherCAT signal is connected to the upper LAN interface. The lower LAN interface relays the signal to other EtherCAT slave devices.

Table 14: EtherCAT slave interface X300, 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   |           |             |

For the EtherCAT slave optional interface (B110), documentation with further information is available:  
[https://infosys.beckhoff.com/content/1033/b110\\_ethercat\\_optioninterface/index.html?id=2623834056269338700](https://infosys.beckhoff.com/content/1033/b110_ethercat_optioninterface/index.html?id=2623834056269338700)

#### Document name

CXxxxx-B110 | EtherCAT Slave Optional Interface.

### 5.4.4 PROFIBUS (x310)

Pin 6 transfers 5 V<sub>DC</sub>, pin 5 transfers GND for the active termination resistor. These must never be used for other functions, as this can lead to destruction of the device.

Pins 3 and 8 transfer the PROFIBUS signals. These must never be swapped over, as this will prevent communication.

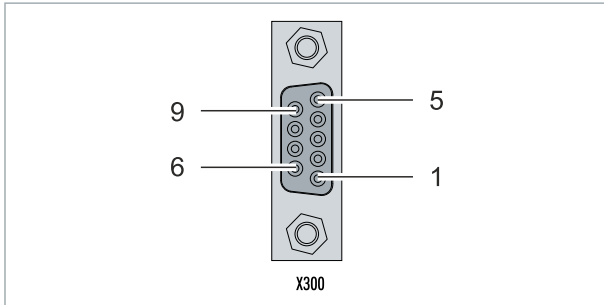


Fig. 10: PROFIBUS interface X310.

The Profibus bus line is connected via a 9-pin D-sub with the following pin assignment:

Table 15: PROFIBUS interface X310, pin assignment.

| Pin | Connection         |
|-----|--------------------|
| 1   | Shielding          |
| 2   | not used           |
| 3   | RxD/TxD-P          |
| 4   | not used           |
| 5   | GND                |
| 6   | +5 V <sub>DC</sub> |
| 7   | not used           |
| 8   | RxD/TxD-N          |
| 9   | not used           |

Table 16: Wire colors of the PROFIBUS line.

| PROFIBUS line | D-sub |
|---------------|-------|
| B red         | Pin 3 |
| A green       | Pin 8 |

For the PROFIBUS optional interface (x310), documentation with further information is available:

[https://infosys.beckhoff.com/content/1033/m310\\_b310\\_profibus\\_optioninterface/index.html?id=2233561431434830097](https://infosys.beckhoff.com/content/1033/m310_b310_profibus_optioninterface/index.html?id=2233561431434830097)

| Document name                                  |
|--|
| CXxxxx-M310/B310   Profibus Optional Interface |

### 5.4.5 CANopen (x510)

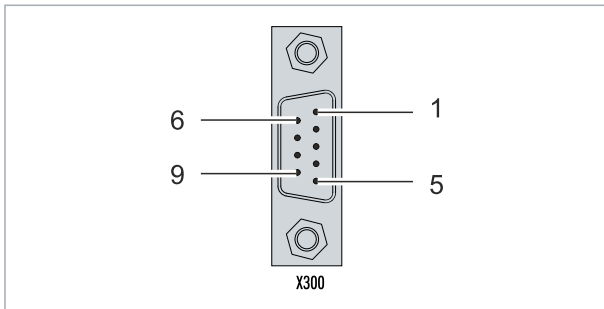


Fig. 11: CANopen interface X510.

The CAN bus line is connected via a 9-pin D-sub connector with the following pin assignment:

Table 17: CANopen interface X510, pin assignment.

| Pin | Connection                                 |
|-----|--|
| 1   | not used                                   |
| 2   | CAN low (CAN-)                             |
| 3   | CAN Ground (internally connected to pin 6) |
| 4   | not used                                   |
| 5   | Shield                                     |
| 6   | CAN Ground (internally connected to pin 3) |
| 7   | CAN high (CAN+)                            |
| 8   | not used                                   |
| 9   | not used                                   |

For the CANopen optional interface (x510), documentation with further information is available:  
[https://infosys.beckhoff.com/content/1033/m510\\_b510\\_canopen\\_optioninterface/index.html?id=1404127979601372947](https://infosys.beckhoff.com/content/1033/m510_b510_canopen_optioninterface/index.html?id=1404127979601372947)

| Document name                                 |
|---|
| CXxxxx-M510/B510   CANopen Optional Interface |



### 5.4.6 PROFINET RT (x930)

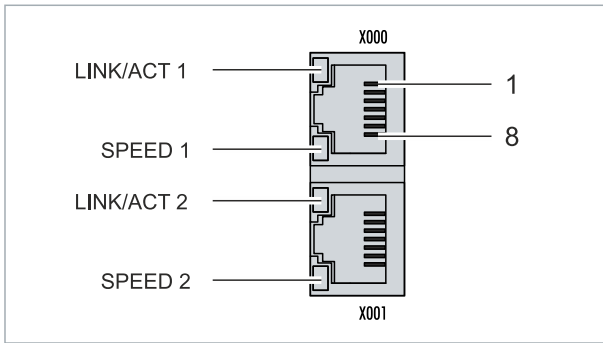


Fig. 12: PROFINET RT interface X300.

Table 18: PROFINET RT interface, 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   |           |             |

For the PROFINET RT optional interface (x930), documentation with further information is available:  
[https://infosys.beckhoff.com/content/1033/m930\\_b930\\_profinet\\_optioninterface/index.html?id=3617310193267164961](https://infosys.beckhoff.com/content/1033/m930_b930_profinet_optioninterface/index.html?id=3617310193267164961)

| Document name                                  |
|--|
| CXxxxx-M930/B930   Profinet Optional Interface |

## 6 Commissioning

### 6.1 Mounting

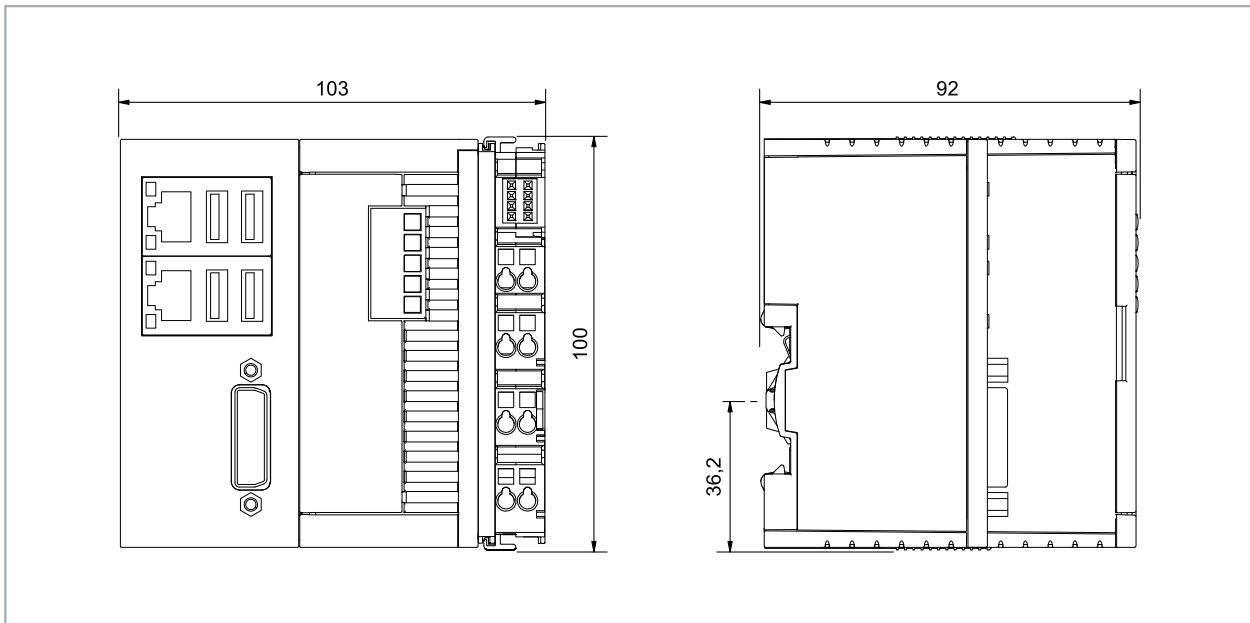


Fig. 13: CX5110-01xx-9020 Embedded PC, dimensions.

### 6.1.1 Permissible installation positions

**NOTICE**

**Overheating**  
 The embedded PC may overheat if the installation position is incorrect or the minimum distances are not adhered to. Adhere to the maximum ambient temperature of 60°C and the mounting instructions.

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

Note the following specifications for the control cabinet:

- The embedded PC should only be operated at ambient temperatures between -25 °C and 60 °C. 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 PC.
- 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.

The embedded PC must be mounted horizontally on the DIN rail. 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 PC is required, in order to ensure adequate ventilation.

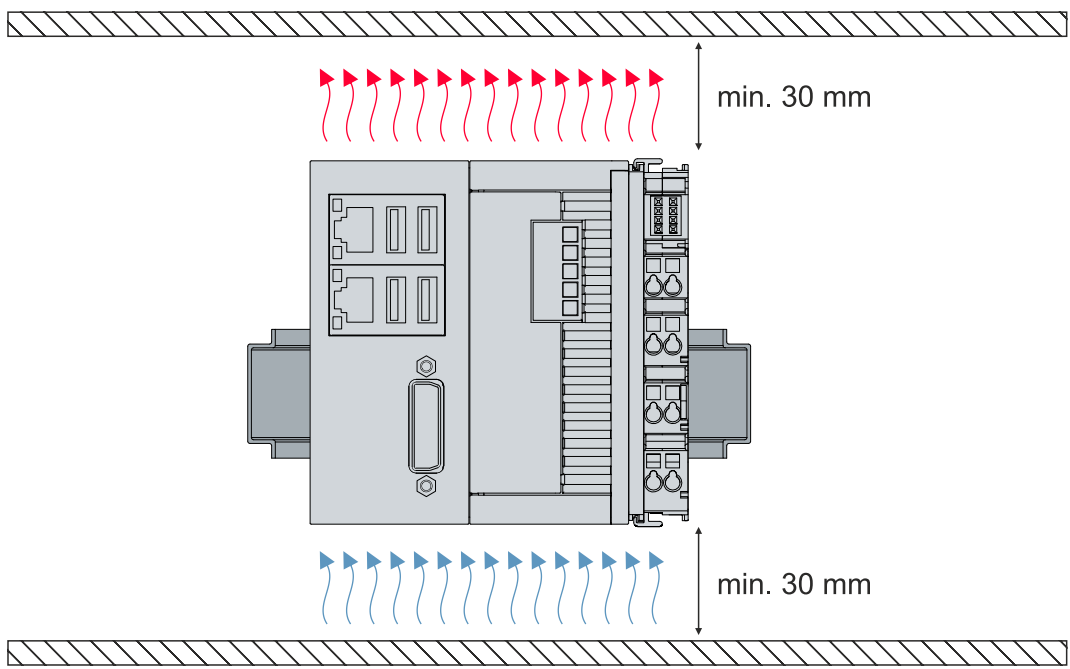


Fig. 14: CX5110-01xx-9020 Embedded PC, permitted installation position.

If vibrations and impact occur in the same direction as the DIN rail, the embedded PC must be secured with an additional bracket, in order to prevent it slipping.

## 6.1.2 Fastening to the DIN rail

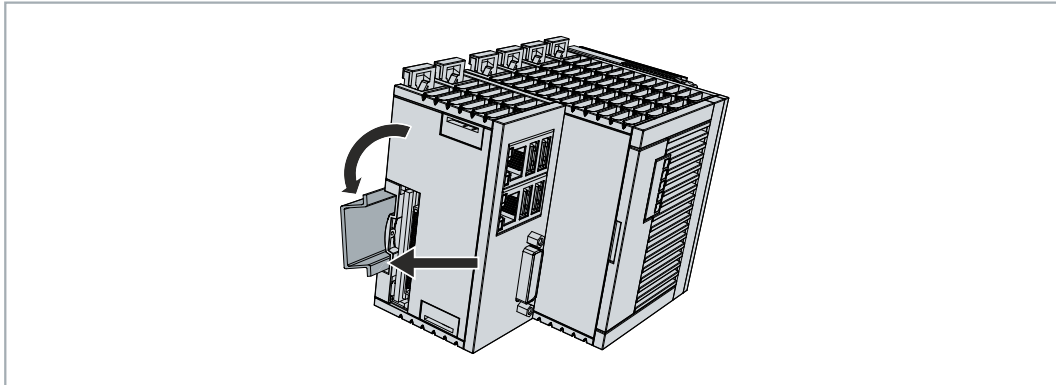
The housing is designed such that the Embedded PC can be pushed against the DIN rail and latched onto it.

Requirements:

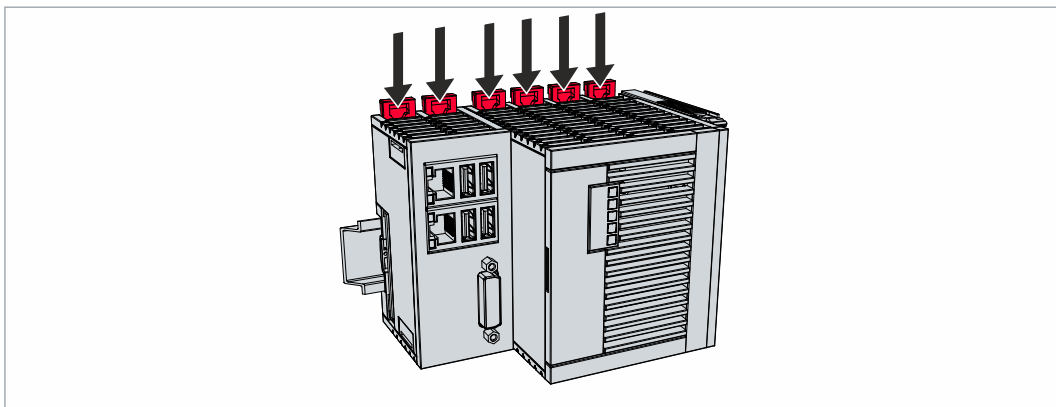
- DIN rail of the type TS35/7.5 or TS35/15 according to EN 60715.

**Fasten the Embedded PC to the DIN rail as follows:**

1. Unlock the latches at the top and bottom.
2. Place the Embedded PC on the DIN rail. Slightly press the Embedded PC onto the DIN rail until a soft click can be heard and the Embedded PC has latched.



3. Then lock the latches again.



⇒ You have installed the Embedded PC successfully. Check again that the mounting is correct and that the Embedded PC is engaged on the DIN rail.

### 6.1.3 Changing the MicroSD card

#### ● Loss of data

**i** MicroSD cards are subjected to heavy load during operation and have to withstand many write cycles and extreme ambient conditions. MicroSD cards from other manufacturer may fail, resulting in data loss.

Only use industrial MicroSD cards provided by Beckhoff.

The MicroSD card slot is intended for a MicroSD card. Data and further programs can be stored here, or Windows Embedded Compact 7 can be installed instead.

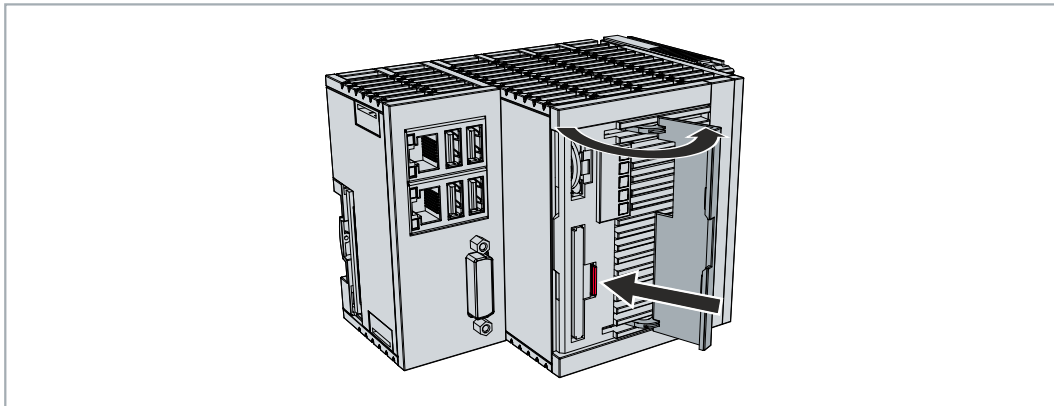
The eject mechanism is based on the push/push principle. Below, we show you how to change the MicroSD card.

Requirements:

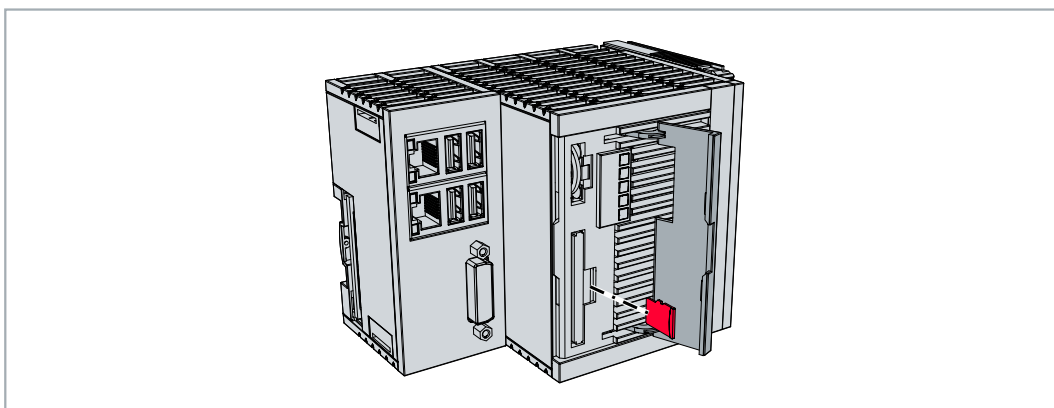
- The Embedded PC must be switched off. The MicroSD card may only be installed or removed in switched-off state.

#### Changing the MicroSD card

1. Gently push the MicroSD card.  
A soft click can be heard when the card is released.



2. The card is lifted by approx. 2-3 mm from the housing.
3. Push the new MicroSD card into the card slot with the contacts at the front. The contacts face to the right.



4. A soft click can be heard when the MicroSD card engages.  
⇒ The card is seated correctly when it is about 1 mm deeper than the front side of the housing.

## 6.1.4 Changing the CFast card

### **i** Loss of data

CFast cards are subjected to heavy load during operation and have to withstand many write cycles and extreme ambient conditions. CFast cards from other manufacturer may fail, resulting in data loss.

Only use industrial CFast cards provided by Beckhoff.

A CFast card is a non-volatile memory. Data to be retained in the event of a power failure should be saved on the CFast card. The CFast cards supplied by Beckhoff are industrial cards with an increased number of write cycles and an extended temperature range (+85 °C).

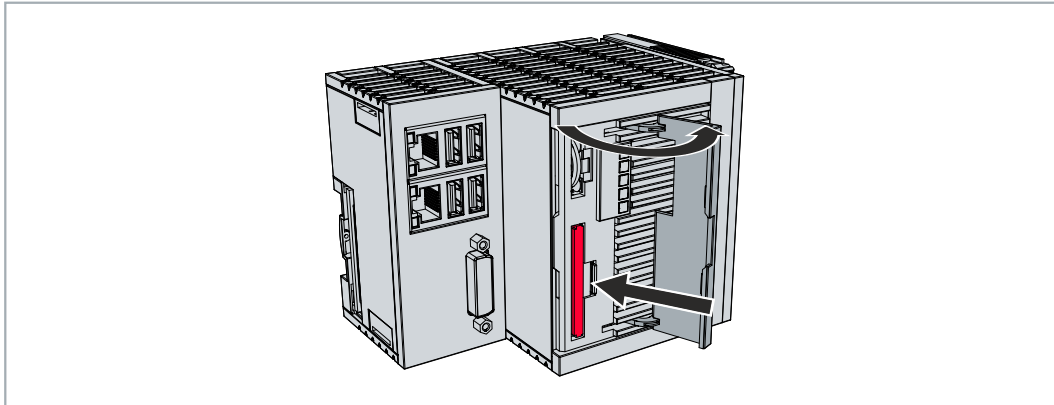
The eject mechanism is based on the push/push principle. Below, we show you how to change the CFast card.

Requirements:

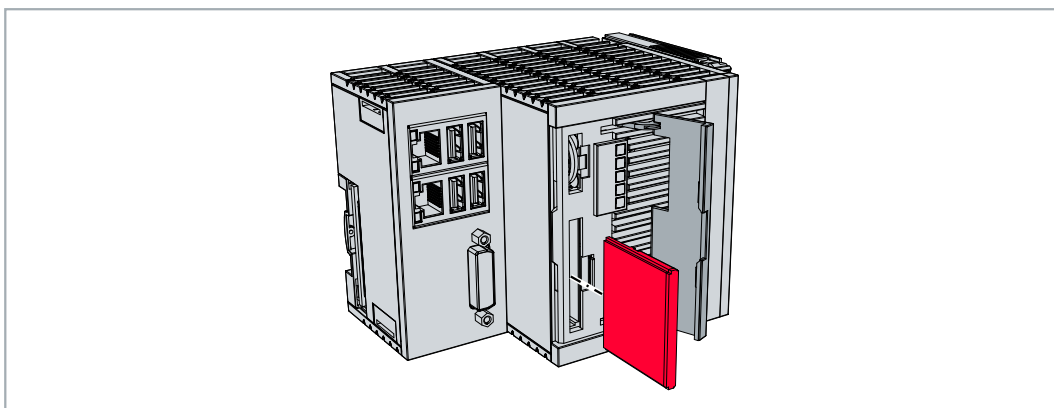
- The Embedded PC must be switched off. The CFast cards may only be installed or removed in switched off state.

### Changing the CFast card

1. Gently push the CFast card.  
A soft click can be heard when the card is released.



2. The card is lifted by approx. 4 mm from the housing.
3. Push the new CFast card into the CFast card slot.



4. A soft click can be heard when the CFast card engages.

⇒ The card is seated correctly when its end is flush with the front side of the housing.

### 6.1.5 Installing passive EtherCAT Terminals

**Incorrectly installed passive EtherCAT Terminals**

**i** The E-bus signal between an embedded PC and the EtherCAT Terminals can be impaired due to incorrectly installed passive EtherCAT Terminals.

Passive EtherCAT Terminals should not be installed directly on the power supply unit.

EtherCAT Terminals that do not take part in active data exchange are referred to as passive terminals. Passive EtherCAT Terminals have no process image and do not require current from the terminal bus (E-bus).

Passive EtherCAT Terminals (e.g. EL9195) can be detected in TwinCAT. The EtherCAT Terminal is displayed without process image in the structure tree, and the value in column "E-bus (mA)" does not change, compared to the preceding EtherCAT Terminal.

| Number | Box Name         | Ad... | Type   | In Size | Out Size | E-Bus (mA) |
|--------|------------------|-------|--------|---------|----------|------------|
| 1      | Term 7 (EK1200)  |       | EK1200 |         |          |            |
| 2      | Term 8 (EL2828)  | 1001  | EL2828 | 1.0     |          | 1890       |
| 3      | Term 9 (EL2828)  | 1002  | EL2828 | 1.0     |          | 1780       |
| 4      | Term 10 (EL9195) |       | EL9195 |         |          | 1780       |
| 5      | Term 11 (EL2828) | 1003  | EL2828 | 1.0     |          | 1670       |
| 6      | Term 12 (EL9011) |       | EL9011 |         |          |            |

Fig. 15: Identifying a passive EtherCAT Terminal in TwinCAT.

The entry "Current consumption via E-Bus" in the technical data of an EtherCAT Terminal indicates whether a particular EtherCAT Terminal requires power from the terminal bus (E-bus).

The following diagram shows the permissible installation of a passive EtherCAT Terminal. The passive EtherCAT Terminal was not directly attached to the power supply unit.

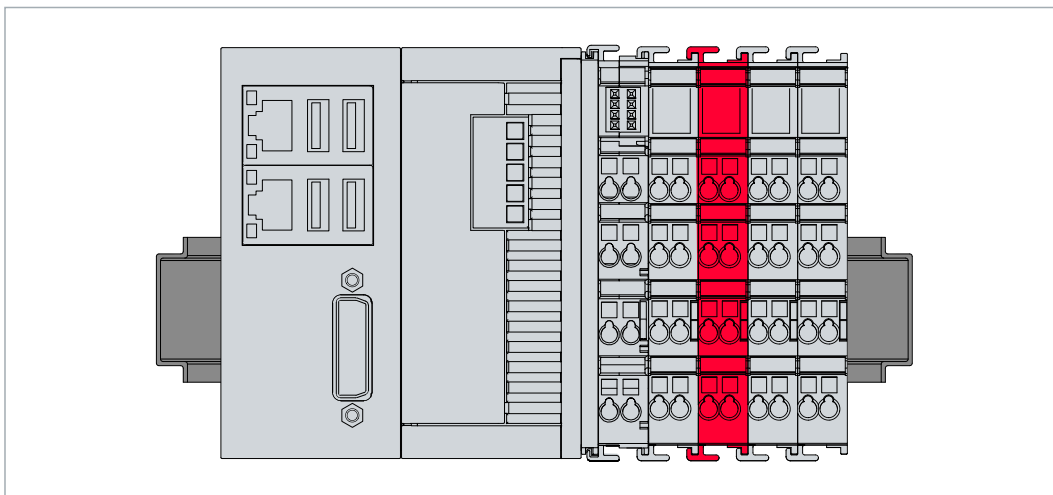


Fig. 16: Passive EtherCAT Terminals, permissible installation.

## 6.2 Power supply

### NOTICE

#### 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 terminal requires 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 PC in all situations.

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.

#### Connections

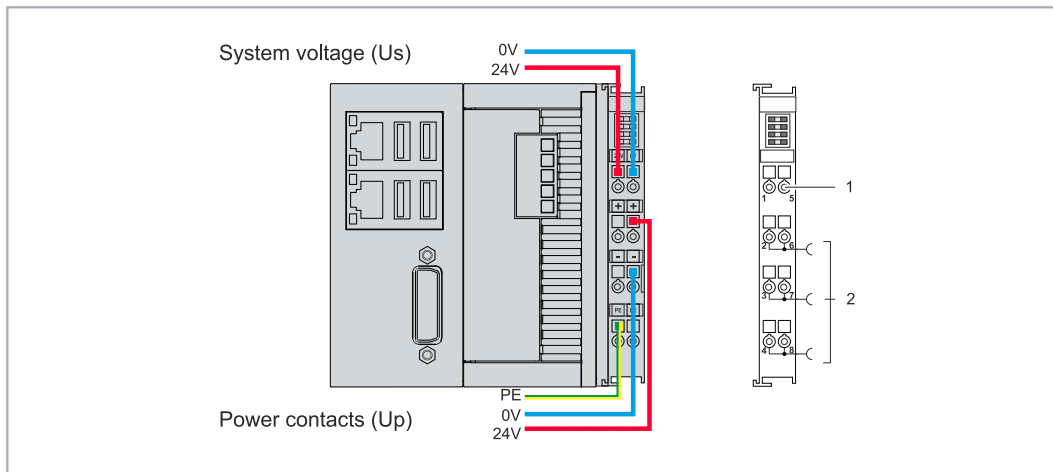


Fig. 17: Connections for system voltage (Us) and power contacts (Up)

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

#### Fuse

- When dimensioning the fuse for the system voltage (Us), observe the maximum power consumption of the embedded PC (see: [Technical data](#) [▶ 72])
- Protect the power contacts (Up) with a fuse with a max. rating of 10 A (slow-blow).

#### 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).



### 6.2.1 Connect embedded PC

The cables of an external voltage source are connected to spring-loaded terminals on the power supply terminal. Observe the required conductor cross-sections and strip lengths.

Table 19: Required conductor cross-sections and strip lengths.

|                                |                             |                   |
|--------------------------------|-----------------------------|-------------------|
| <b>Conductor 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         |

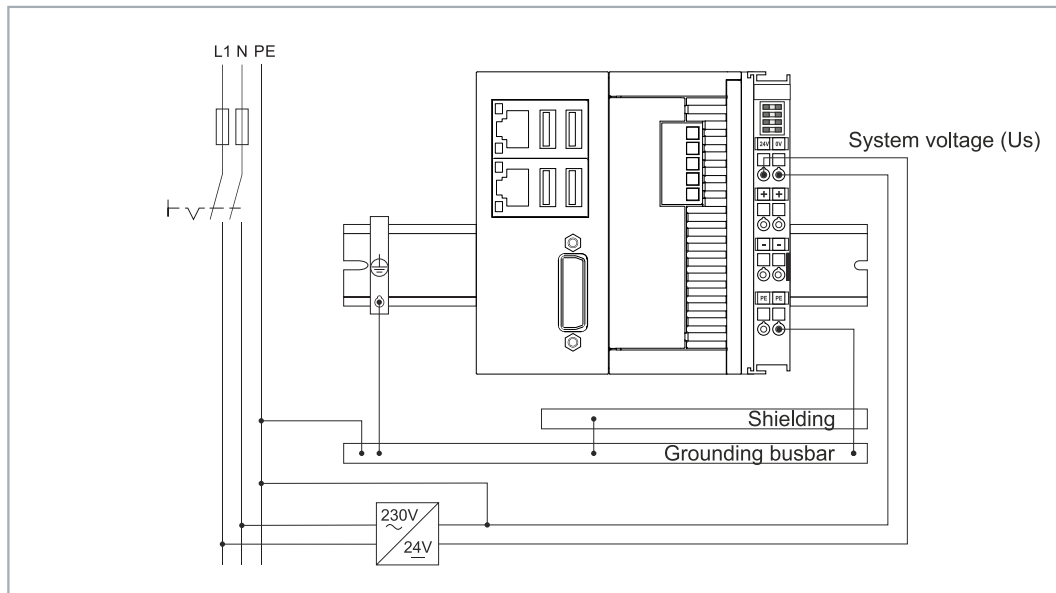
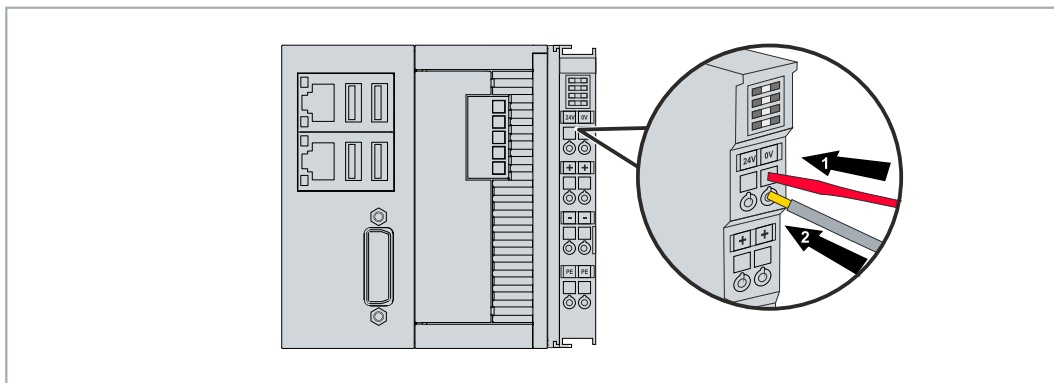


Fig. 18: Connection example with a CX5110-01xx-9020.

**Connect the embedded PC as follows:**

1. Open a spring-loaded terminal by slightly pushing with a screwdriver or a rod into the square opening above the terminal.



2. The wire can now be inserted into the round terminal opening without any force.
  3. The terminal closes automatically when the pressure is released, holding the wire safely and permanently.
- ⇒ You have successfully connected the voltage source to the power supply terminal when the two upper LEDs of the power supply terminal light up green.

The left LED (Us 24V) indicates the supply of the basic CPU module and the terminal bus. The right LED (Up 24V) indicates the bus terminal supply via the power contacts.

## 6.2.2 UL requirements

The CX5110-01xx-9020 Embedded PCs are UL-certified. The corresponding UL label can be found on the name plate.

The CX5110-01xx-9020 Embedded PCs can thus be used in areas in which special UL requirements have to be met. These requirements apply to the system voltage ( $U_s$ ) and the power contacts ( $U_p$ ). Applications without special UL requirements are not affected by UL regulations.

UL requirements:

- The embedded PCs must not be connected to unlimited voltage sources.
- Embedded PCs may only be supplied from a 24 V DC voltage source. The voltage source must be insulated and protected with a fuse of maximum 4 A (corresponding to UL248).
- Or the power supply must originate from a voltage source that corresponds to NEC class 2. An NEC class 2 voltage source must not be connected in series or parallel with another NEC class 2 voltage source.

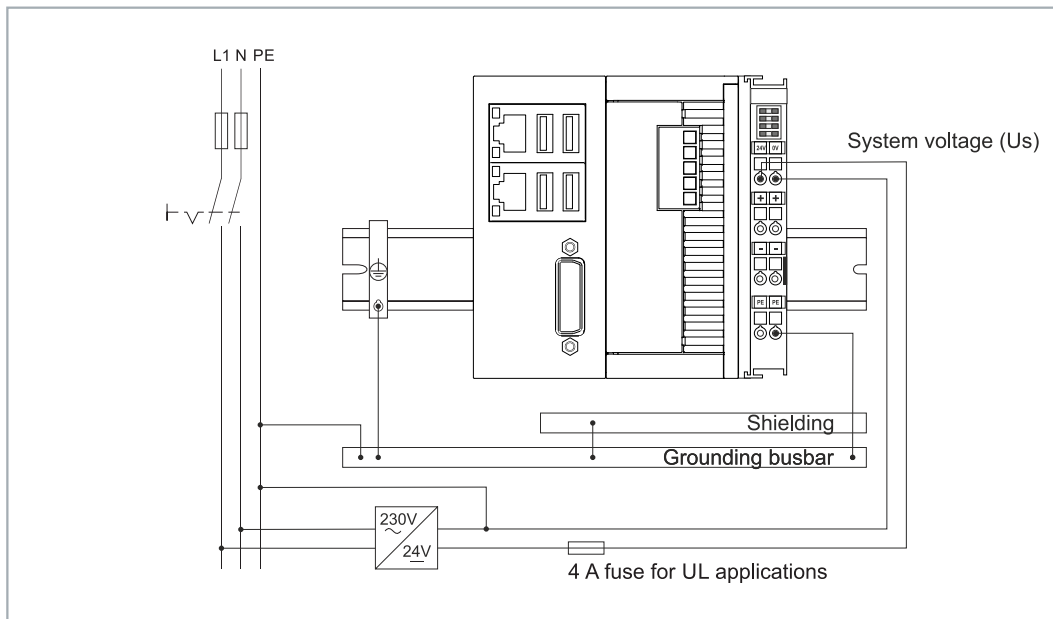


Fig. 19: Connection example for areas with special UL requirements.

## 6.3 Switching on

Please ensure that the Embedded PC is fully configured before switching on the Embedded PC.

**Switch on the Embedded PC as follows:**

1. Ensure that all extension, system and fieldbus modules are connected correctly.
  2. Check that you have chosen the correct installation position.
  3. Check whether the Embedded PC is mounted securely on the DIN rail and all required Bus Terminals are connected.
  4. Only then switch on the power supply for the power supply unit.
- ⇒ The Embedded PC starts automatically when the external power supply is switched on. The pre-installed operating system is started and all connected extension, system and fieldbus modules are configured.

## 6.4 Switching off

---

### **i** Loss of data

If the Embedded PC is switched off during operation, data on the CFast card or other hard disks may be lost.

Do not disconnect the Embedded PC during operation.

---

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 switch off the power supply unit first and then disconnect the 24 V line.

#### **Switch off the Embedded PC as follows:**

1. Stop all running programs properly, e.g. the control software on the Embedded PC.
2. Shut down the operating system.
3. Do not switch off the external power supply until all other tasks have been completed, in order to switch off the Embedded PC.

# 7 Configuration

## 7.1 Beckhoff Device Manager

### 7.1.1 Starting the Beckhoff Device Manager

Using the Beckhoff Device Manager, an industrial PC can be configured by remote access with the aid 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 443 (TCP).

Requirements:

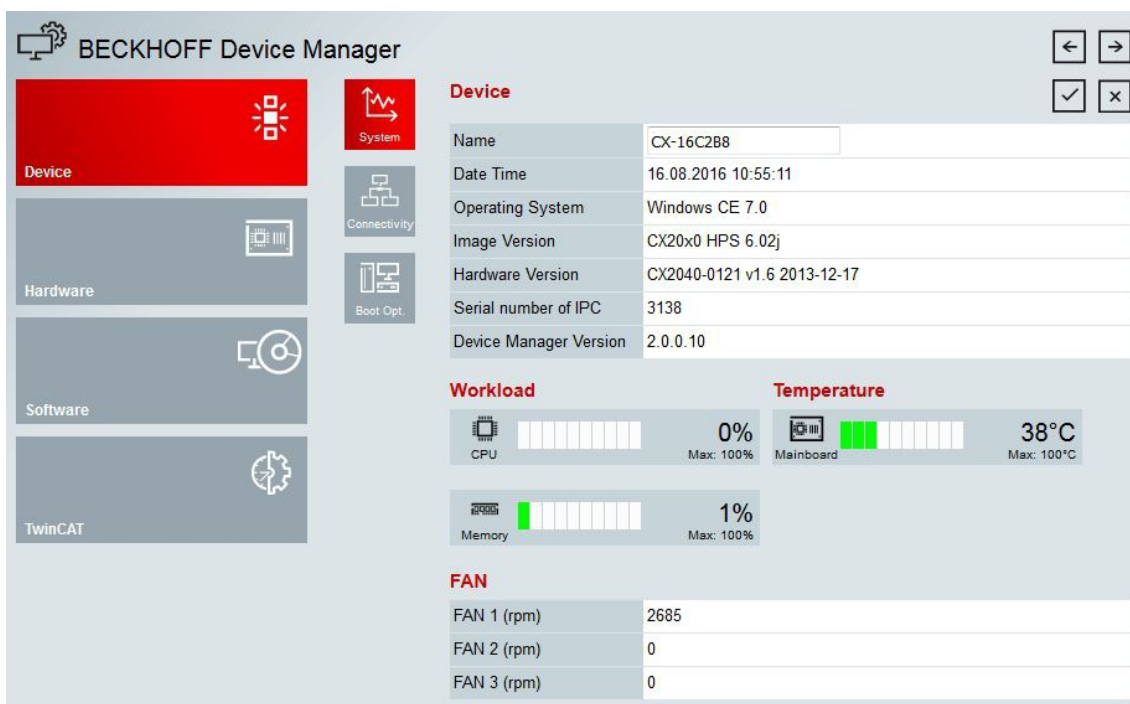
- Host PC and embedded PC must be located in the same network. Depending on the operating system version, the network firewall must allow access via port 80 (HTTP) or port 443 (HTTPS).
- IP address or host name of the embedded PC.

Table 20: Access data for the Beckhoff Device Manager on delivery.

| User name     | Password |
|---------------|----------|
| Administrator | 1        |

**Start the Beckhoff Device Manager as follows:**

1. Open a web browser on the host PC.
2. Enter the IP address or the host name of the industrial PC in the web browser to start the Beckhoff Device Manager.
  - Example with IP address: `https://169.254.136.237/config`
  - Example with host name: `https://CX-16C2B8/config`
3. Enter the user name and password. The start page appears:



⇒ Navigate forward in the menu and configure the industrial PC. Note that modifications only become active once they have been confirmed. It may be necessary to restart the industrial PC.

## 7.1.2 Enabling a remote display

So that you can remotely access an industrial PC with CE operating system, you must first activate Remote Display in the Beckhoff Device Manager. The remote display is disabled by default.

Requirements:

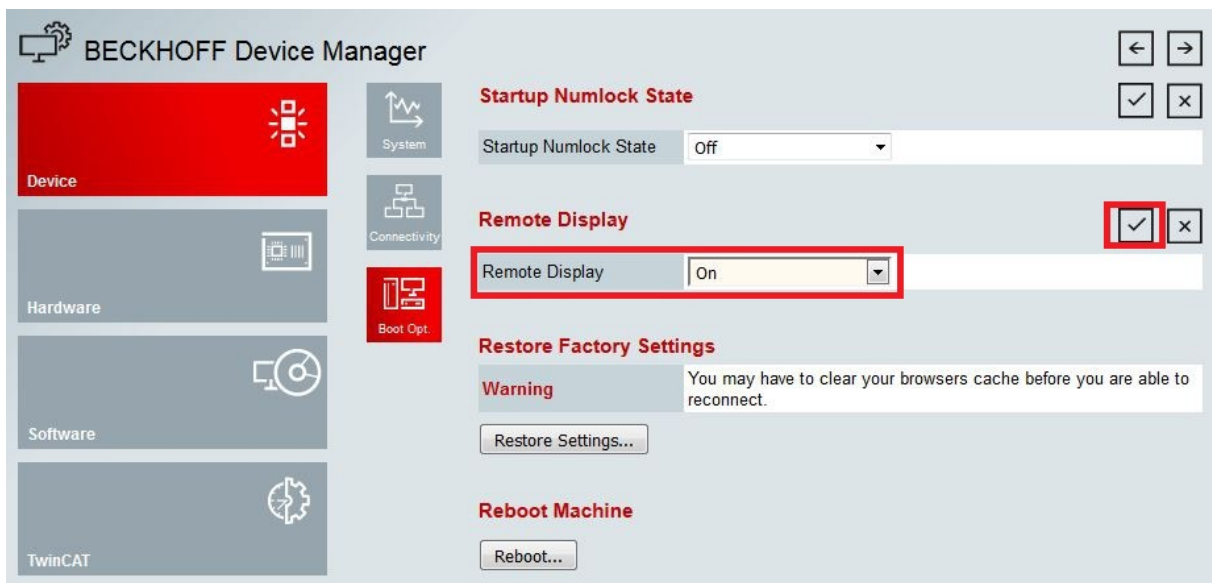
- Host PC and embedded PC must be located in the same network. Depending on the operating system version, the network firewall must allow access via port 80 (HTTP) or port 443 (HTTPS).
- The IP address or the host name of the embedded PC must be known.

Table 21: Access data for the Beckhoff Device Manager on delivery.

| Operating system           | Access data                             |
|----------------------------|---|
| Windows Embedded Compact 7 | User name: Administrator<br>Password: 1 |

Enable the remote display as follows:

1. Open a web browser on the host PC.
2. Enter the IP address or the host name of the industrial PC in the web browser to start the Beckhoff Device Manager.
  - Example with IP address: `https://169.254.136.237/config`
  - Example with host name: `https://CX-16C2B8/config`
3. Enter the user name and password. The start page appears.
4. Click **Device** and then click **Boot Opt.**



5. Under **Remote Display** select the option **On** and confirm the settings.
  6. In the information window click **OK** to accept the settings.
- ⇒ You have successfully activated Remote Display on the industrial PC. After restarting, you can remotely access your industrial PC.

### 7.1.3 Starting a remote connection

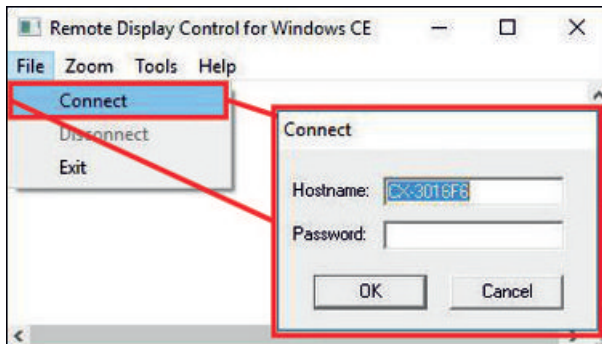
With the aid of the Remote Display Control program (CERHOST), a remote connection can be established and an Industrial PC with CE operating system can be remotely controlled from a host PC.

Requirements:

- Remote Display is active. See: Enabling a remote display.
- Host name of the Embedded PC.
- Remote Display Control (CERHOST). Download under: cerhost.zip (Resources/zip/9007204301816203.zip)

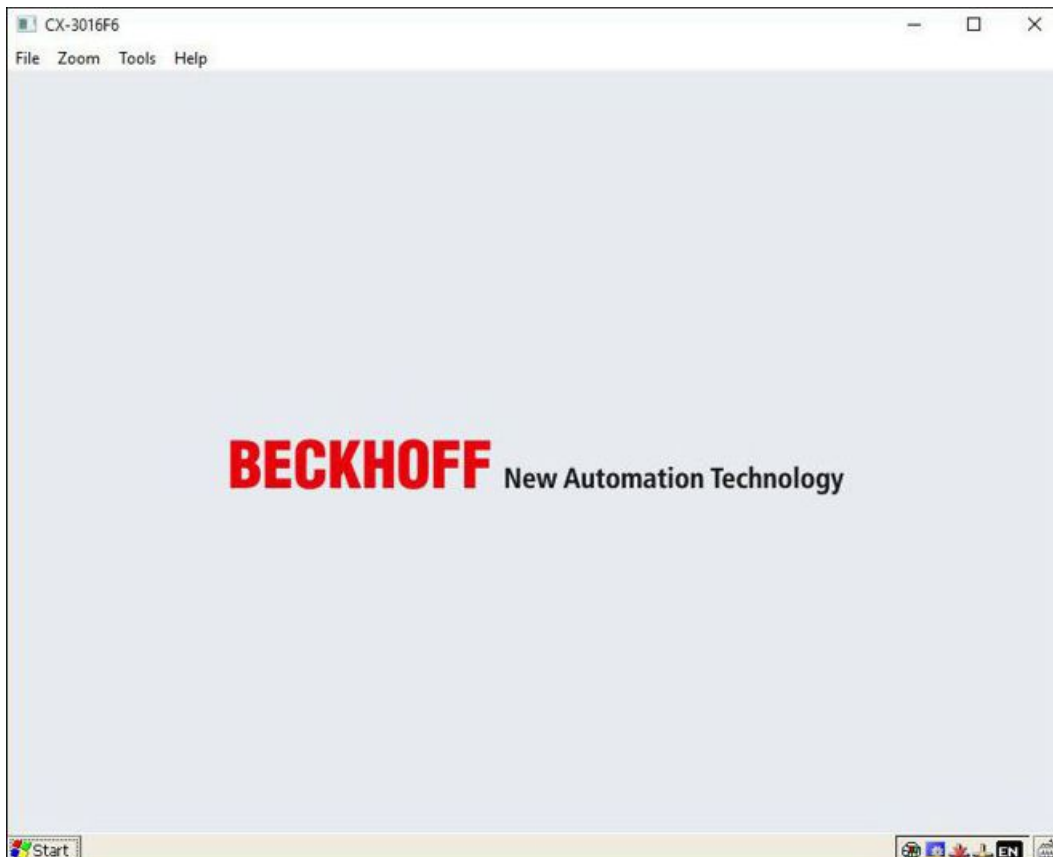
**Start the remote connection as follows:**

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.



## 7.2 Configuration of switched Ethernet interfaces

### **i** High data throughput generates system load

Increased data throughput can have a negative effect on the system load for switched Ethernet interfaces. Consider this behavior for your configuration.

In contrast to the CX9020, the Ethernet interfaces of the CX5110-01xx-9020 are not switched. The Ethernet interfaces (X000, X001) are independent of each other ex factory, they can be configured differently and are configured for EtherCAT communication.

To ensure that the CX5110-01xx-9020 behaves technically in the same way as the CX9020, the two Ethernet interfaces (X000, X001) can be switched under Windows Compact 7. The appropriate drivers and registry files are integrated in the image of the CX5110-01xx-9020.

#### Proceed as follows:

1. Click **Start > Run** and start the Explorer.



2. Navigate to the directory `\Hard Disk\RegFiles\Samples\Common`.
  3. Enable the registry file `MacBridge_Enable.reg` and confirm the notice to add the information to the registry.
  4. Restart the device so that the changes are applied.
- ⇒ After the restart, the Ethernet interfaces are switched and dependent of each other. The network adapters "PCI-TCI8254x1" and "PCI-TCI8254x2" are automatically deactivated and a new network adapter named "MBRIDGE1" is created instead.



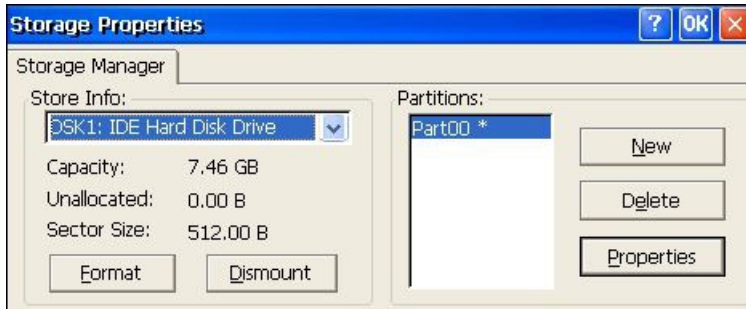
The setting can be deactivated and undone with the registry file `MacBridge_Disable.reg`.

## 7.3 Formatting storage media

For storage media to be recognized under Windows Embedded Compact 7, they must be formatted in FAT32 format. The formatting of the storage media can also be started within the operating system.

### Proceed as follows:

1. Click **Start > Control Panel** and launch Explorer.
2. Click on the **Storage Manager** button.
3. In the **Store Info** field, select the storage medium you want to format and click the **Format** button.



4. Then click the **New** button to create a new partition.  
⇒ The storage medium is formatted in FAT32 format and the partition is included in the operating system.



## 7.4 TwinCAT

### 7.4.1 Tree view

The Tree View chapter can be used as an example for creating a project without actual hardware. All devices and components of an embedded PC must be added manually in TwinCAT 3.

The smallest possible configuration of the CX5110-01xx-9020 Embedded PC is created as follows in the tree view under TwinCAT 3:

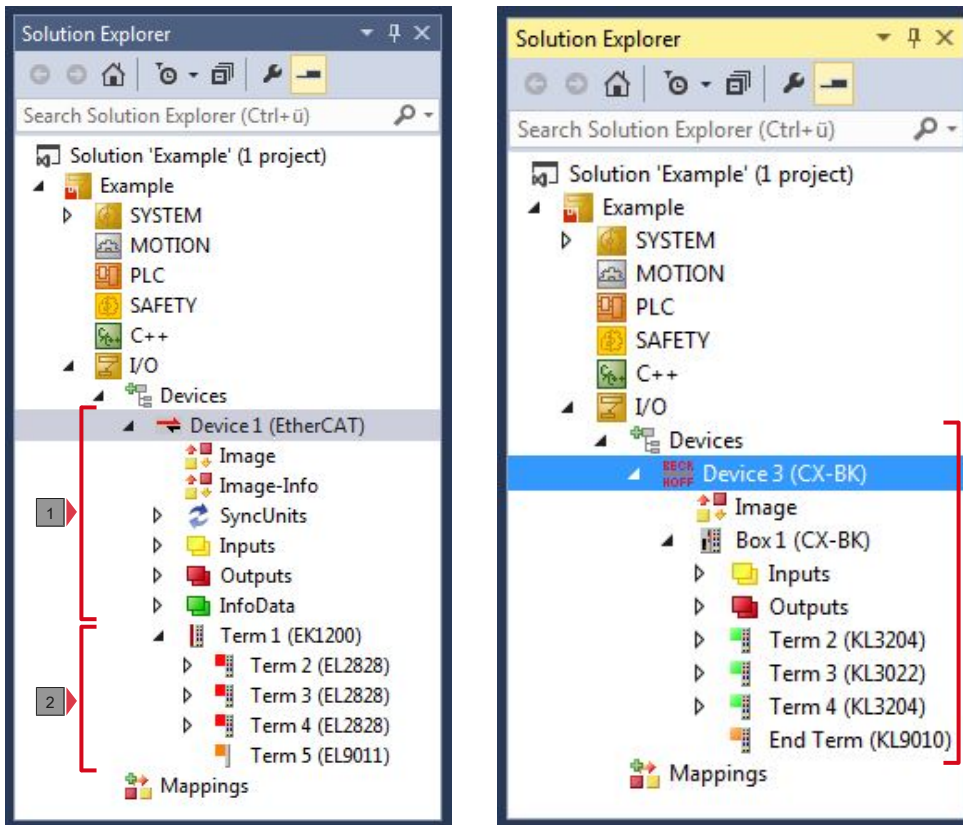


Fig. 20: CX5110-01xx-9020 Embedded PC in the tree view of TwinCAT 3, with attached EtherCAT Terminals (left) or Bus Terminals (right).

The configuration in the tree view differs depending on whether EtherCAT Terminals or Bus Terminals are connected to the Embedded PC.

Table 22: Key for the tree view.

| No. | Description   |
|-----|---|
| 1   | The CX5110-01xx-9020 Embedded PC with EtherCAT Terminals is added as EtherCAT master. Variables for diagnostic purposes are listed under inputs or outputs. |
| 2   | EtherCAT Terminals (E-bus) are displayed under the EK1200 Bus Coupler in the tree view.   |
| 3   | If Bus Terminals (K-bus) are used together with a CX5110-01xx-9020 Embedded PC, the Bus Coupler (CX-BK) is added together with the Bus Terminals.           |

## 7.4.2 Searching for target systems

Before you can work with the devices, you must connect your local computer to the target device. Then you can search for devices with the help of the IP address or the host name.

The local PC and the target devices 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.

Prerequisites for this step:

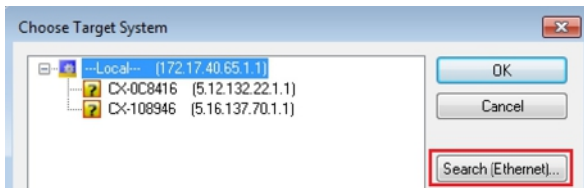
- TwinCAT 3 must be in Config mode.
- IP address or host name of the device.

**Search for the devices as follows:**

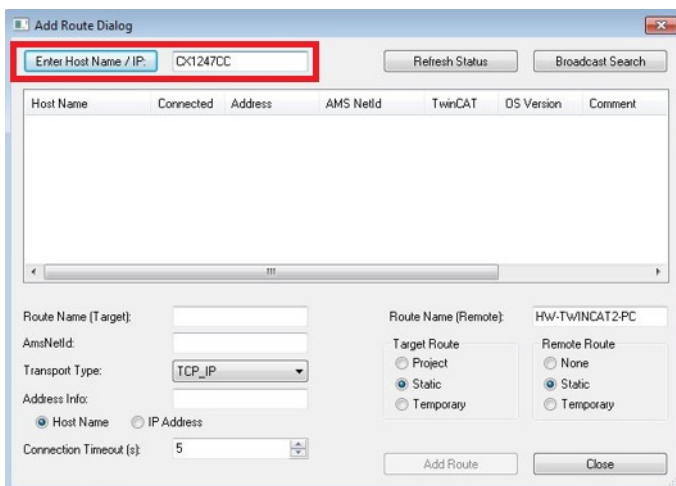
1. In the menu at the top click on **File > New > Project** and create a new TwinCAT XAE project.
2. In the tree view on the left click on **SYSTEM**, and then **Choose Target**.



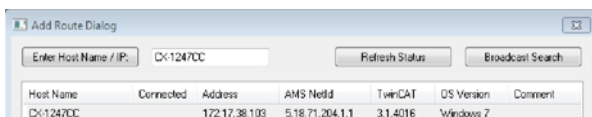
3. Click on **Search (Ethernet)**.



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

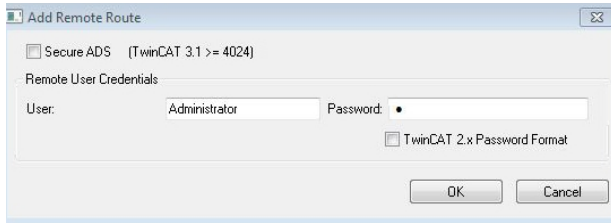


5. Mark the device found and click on **Add Route**.



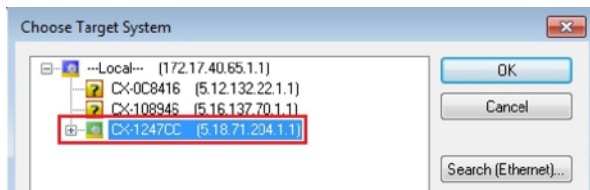
The Logon Information window appears.

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 Dialog. 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.

### 7.4.3 Scanning an Embedded PC

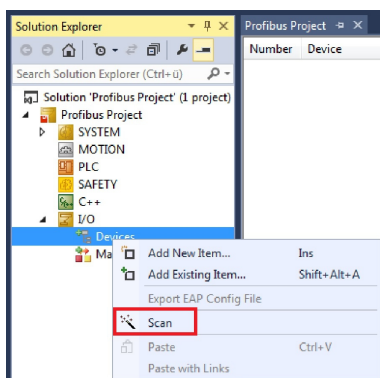
This step shows how to scan an Embedded PC in TwinCAT and then further configure it.

Prerequisites for this step:

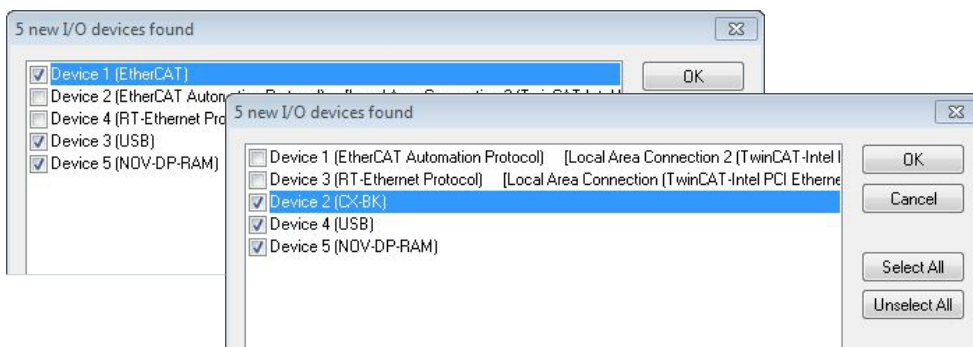
- Selected target device.

**Add the Embedded PC as follows:**

1. Start TwinCAT and open an empty project.
2. In the tree view on the left, right-click on **I/O Devices**.
3. In the context menu click on **Scan**.



4. Select the devices you want to use and confirm the selection with **OK**. Only devices that are actual available are offered for selection.



For Embedded PCs with connected Bus Terminals (K-bus) a Bus Coupler device (CX-BK) is displayed. For EtherCAT Terminals (E-bus) the EtherCAT coupler is added automatically.

5. Confirm the request with **Yes**, in order to look for boxes.
  6. Confirm the request whether to enable FreeRun with **Yes**.
- ⇒ The Embedded PC was successfully scanned in TwinCAT and is displayed in the tree view with the inputs and outputs.  
The Tree view chapter illustrates how Embedded PCs with connected Bus or EtherCAT Terminals are displayed.

### 7.4.4 Configuring EtherCAT cable redundancy.

The embedded PC has two independent Ethernet interfaces, which can be used for EtherCAT cable redundancy. Cable redundancy offers resilience for the cabling. Interruptions of the EtherCAT communication due to wire break or unplugged LAN cables are avoided.

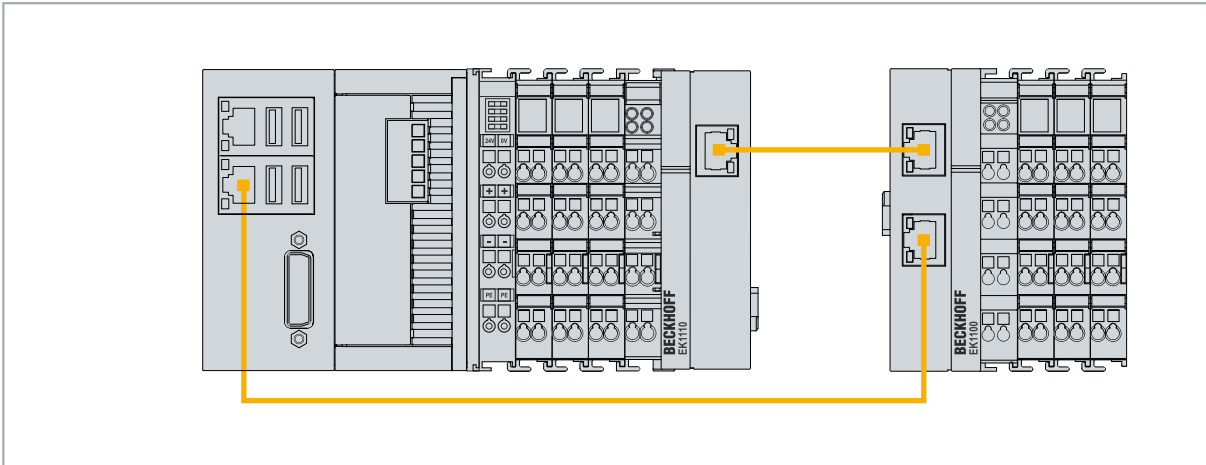


Fig. 21: Example configuration of a CX5110-01xx-9020 with EtherCAT cable redundancy.

Interference at the individual terminals is not intercepted by the cable redundancy.

Table 23: Cable redundancy, hardware for sample configuration.

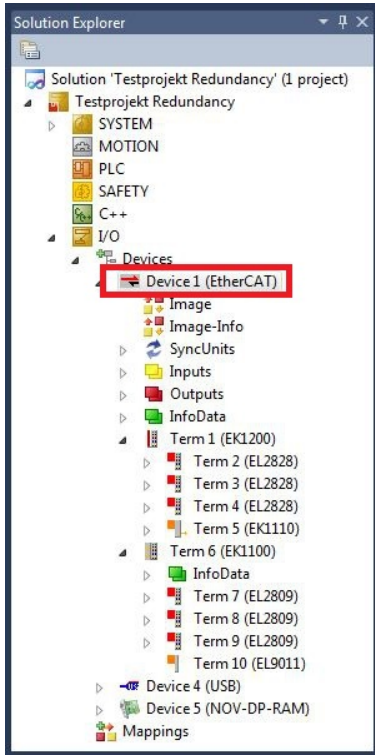
| Type               | Description   |
|--------------------|---|
| Embedded PC        | Is the EtherCAT master in the example.  |
| EK1110 Bus Coupler | EtherCAT extension can be used to extend an EtherCAT segment by up to 100 m.              |
| EK1100 Bus Coupler | The Bus Coupler relays the EtherCAT signal to connected EtherCAT Terminals.               |
| EtherCAT Terminals | Any number of EtherCAT Terminals can be connected to the Embedded PC and the Bus Coupler. |

Requirements:

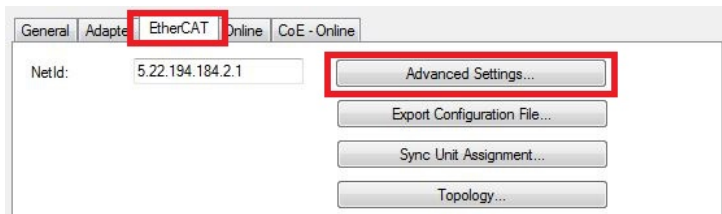
- For TwinCAT 2 you have to install and license the supplement TS622x | TwinCAT EtherCAT Redundancy on the embedded PC:  
<http://www.beckhoff.de/forms/twincat3/warenkorb.aspx?lg=de&title=TS622x-EtherCAT-Redundancy&version=1.0.2>
- In TwinCAT 3 the supplement is already included and only has to be licensed.
- Hardware wired as EtherCAT ring (see Fig.: Smallest possible configuration for EtherCAT cable redundancy) and added in TwinCAT.

**Configure EtherCAT cable redundancy as follows:**

1. In the tree view click on the EtherCAT master.

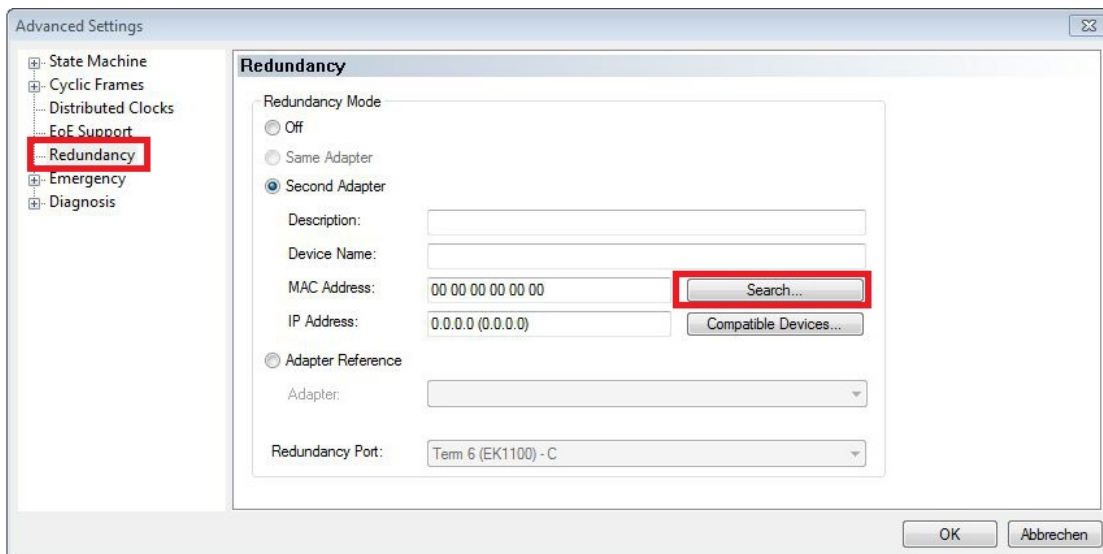


2. Click on the **EtherCAT** tab, then **Advanced Settings**.

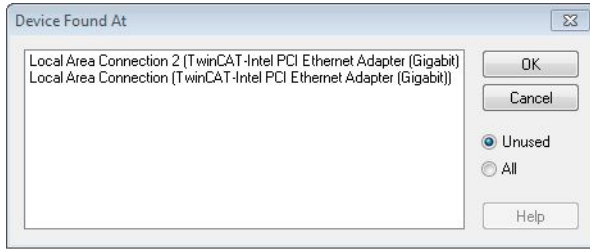


3. Click on **Redundancy** in the structure tree on the left.

4. Click the **Second Adapter** option and then the **Search** button.



5. Select the appropriate LAN connection according to your cabling at the embedded PC.



6. Confirm your settings with **Ok**.

⇒ You have successfully configured cable redundancy. The EtherCAT slaves configured for cable redundancy are displayed in the **Online** tab.

The state of the individual EtherCAT slaves can be found in the **State** column. If, for example, the cable connection between the EK1100 and EK1110 Bus Couplers is interrupted, the status of the Bus Coupler changes. The message "LINK\_MIS B" and "LINK\_MIS A" then appears in the State column.

| No | Addr | Name            | State        | CRC     |
|----|------|-----------------|--------------|---------|
| 1  | 1001 | Term 2 (EL2828) | OP           | 0, 0    |
| 2  | 1002 | Term 3 (EL2828) | OP           | 0, 0    |
| 3  | 1003 | Term 4 (EL2828) | OP           | 0, 0    |
| 4  | 1004 | Term 5 (EK1110) | OP LNK_MIS B | 0       |
| 5  | 1005 | Term 6 (EK1100) | OP LNK_MIS A | 0, 0, 0 |
| 6  | 1006 | Term 7 (EL2809) | OP           | 0, 0    |
| 7  | 1007 | Term 8 (EL2809) | OP           | 0, 0    |
| 8  | 1008 | Term 9 (EL2809) | OP           | 0       |

Although the connection between the Bus Couplers is interrupted, the EtherCAT Terminals connected to the EK1100 Bus Coupler do not have a fault.

If the cable connection is interrupted at the same point without cable redundancy, a fault is displayed for the terminals in the State column.

| No | Addr | Name            | State        | CRC  |
|----|------|-----------------|--------------|------|
| 1  | 1001 | Term 2 (EL2828) | OP           | 0, 0 |
| 2  | 1002 | Term 3 (EL2828) | OP           | 0, 0 |
| 3  | 1003 | Term 4 (EL2828) | OP           | 0, 0 |
| 4  | 1004 | Term 5 (EK1110) | OP LNK_MIS B | 0    |
| 5  | 1005 | Term 6 (EK1100) | INIT NO_COMM | 0, 0 |
| 6  | 1006 | Term 7 (EL2809) | INIT NO_COMM | 0, 0 |
| 7  | 1007 | Term 8 (EL2809) | INIT NO_COMM | 0, 0 |
| 8  | 1008 | Term 9 (EL2809) | INIT NO_COMM | 0    |

## 7.4.5 Using a hardware watchdog

The function block **FB\_PcWatchdog\_BAPI** activates a hardware watchdog on the Embedded PC. The watchdog can be used to automatically restart systems that have entered an infinite loop or where the PLC has stopped.

The watchdog is activated with **bExecute = TRUE** and **nWatchdogTimeS >= 1s**.

Once the watchdog has been activated, the function block must be called cyclically and at shorter intervals than **nWatchdogTimeS**, because the Embedded PC automatically restarts if the set time is less than **nWatchdogTimeS**.

### NOTICE

#### Unwanted restart

The watchdog restarts the Embedded PC as soon as the time set for **nWatchdogTimeS** elapses.

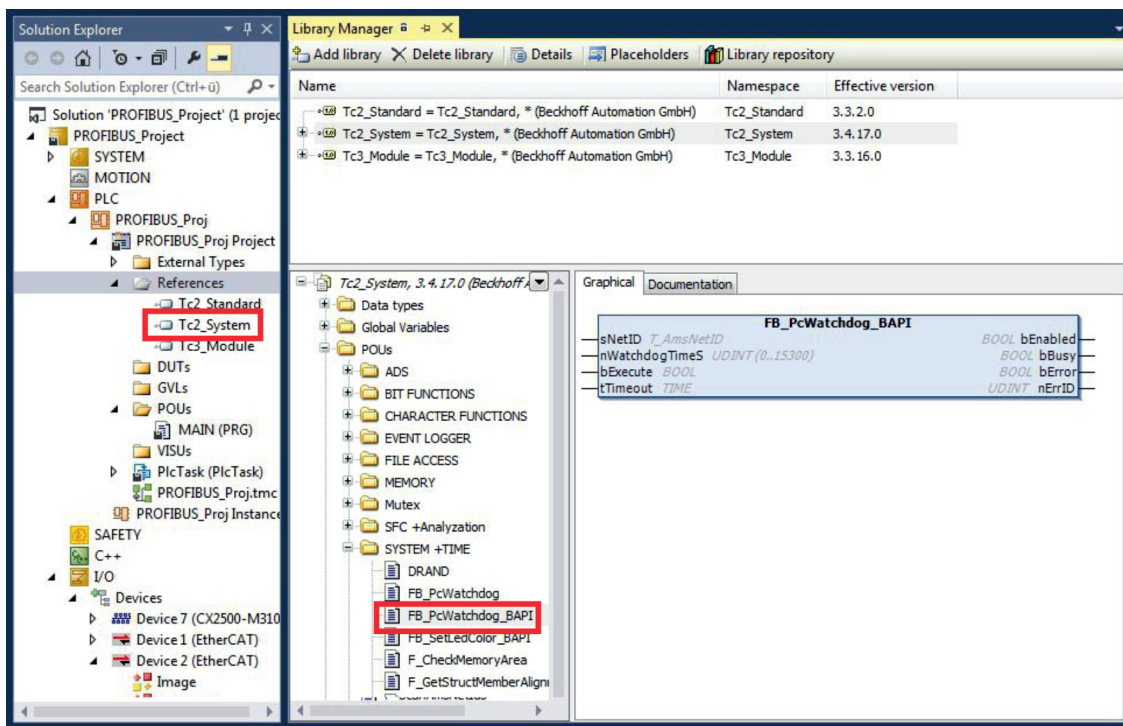
Be aware of this behavior and disable the watchdog if you use breakpoints, carry out a PLC reset or an overall reset, stop TwinCAT, switch to config mode or activate the configuration.

#### Requirements:

- Tc2\_System library.
- TwinCAT v3.1.0
- A previously created PLC project in TwinCAT.

#### Locating the function block in TwinCAT:

1. Double-click on **Tc2\_System** in the tree view under **PLC > PLC project > References**. The Library Manager appears.



2. Under **Tc2\_System > POUs > SYSTEM +TIME** click on the function block **FB\_PcWatchdog\_BAPI**.  
 ⇒ The description of the function block can then be found under the **Documentation** tab or in the library description under: **FB\_PcWatchDog\_BAPI**. If necessary, you can install the **Tc2\_System** library at a later stage via the **Add Library** button in the Library Manager.



## 8 NOVRAM

The NOVRAM can be used to reliably save important variable values, such as production data or counter values, in the event of a power failure. The memory size of the NOVRAM is limited and only suitable for smaller data quantities up to 63 kB.

In this chapter we show you how the NOVRAM is used in TwinCAT 3.

### Functioning

The NOVRAM (Non-Volatile Random Access Memory) is a special memory component that is used to reliably save important data. The NOVRAM consists of two sections, a volatile memory and a non-volatile memory.

TwinCAT only writes to the volatile section of the NOVRAM. In the event of a power failure, the data are automatically copied from the volatile memory into the non-volatile memory. The energy required for this process is supplied by a capacitor. As soon as the power supply is restored, the data are automatically copied back into the volatile memory, so that TwinCAT can continue to use them.

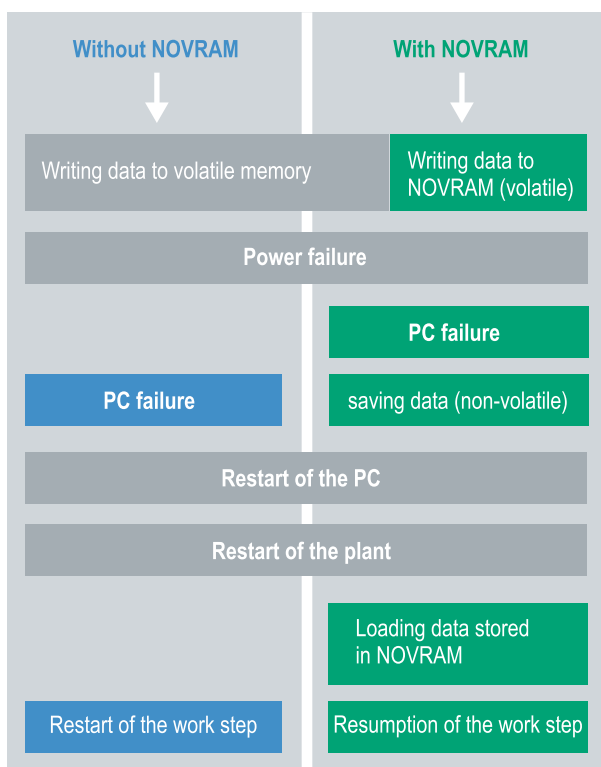


Fig. 22: Controller behavior with and without NOVRAM.

### Memory size

The NOVRAM has a capacity of 128 kB. However, for reasons of data consistency, effectively less than 63 kB of data can be securely saved in the NOVRAM. The data are saved cyclically and alternately based on the dual buffer principle, in order to avoid the risk of data inconsistency.

### Requirements

| Development environment | Target platforms         | Hardware                               | PLC libraries to include |
|-------------------------|--------------------------|--|--------------------------|
| TwinCAT 3.1 Build: 4020 | PC or CX (x86, x64, ARM) | CX70xx, CX9020, CX20x0, CX20x2, CX20x3 | Tc2_ioFunctions          |

## 8.1 Creating and linking variables

Once you have created a Retain Handler in TwinCAT, you can declare variables in the PLC and link them to the Retain Handler. The variables have to be identified in the PLC with the keyword VAR\_RETAIN.

Prerequisite for this step:

- A PLC project created in TwinCAT.

**Create variables as follows:**

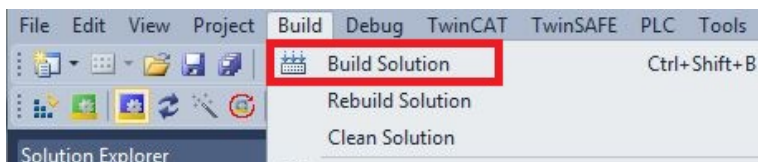
1. Create the variables in your PLC project in a VAR\_RETAIN area.

```

1  PROGRAM MAIN
2
3  VAR_RETAIN
4  x      :UINT;
5  y      :UINT;
6  z      :UINT;
7  END_VAR
8
9  VAR
10
11     datain AT$I*: REAL;
12     dataout AT$Q*: BYTE;
13
14  END_VAR

```

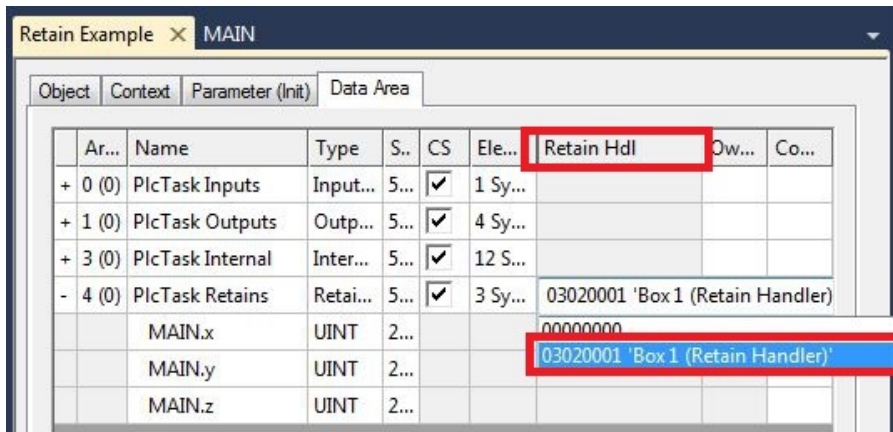
2. Click on **Build** in the toolbar at the top, then on **Build Solution**.



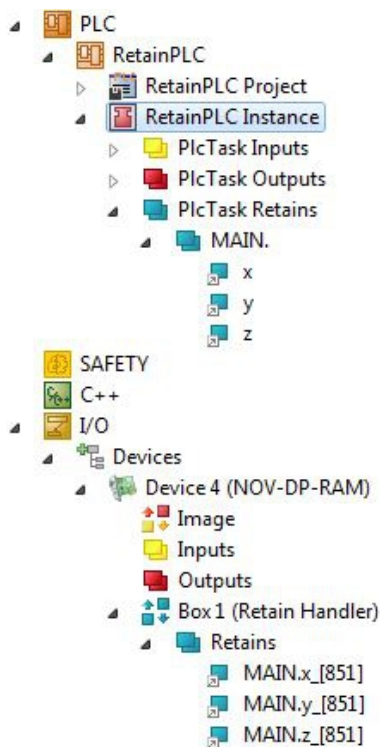
3. Click on **PLC Instance** in the tree view on the left and then on the tab **Data Area**.

| Ar...   | Name             | Type     | S... | CS | Ele...  | Retain Hdl | Ow... | Co... |
|---------|------------------|----------|------|----|---------|------------|-------|-------|
| + 0 (0) | PlcTask Inputs   | Input... | 5... | ✓  | 1 Sy... |            |       |       |
| + 1 (0) | PlcTask Outputs  | Outp...  | 5... | ✓  | 4 Sy... |            |       |       |
| + 3 (0) | PlcTask Internal | Inter... | 5... | ✓  | 12 S... |            |       |       |
| - 4 (0) | PlcTask Retains  | Retai... | 5... | ✓  | 3 Sy... | 00000000   |       |       |
|         | MAIN.x           | UINT     | 2... |    |         |            |       |       |
|         | MAIN.y           | UINT     | 2... |    |         |            |       |       |
|         | MAIN.z           | UINT     | 2... |    |         |            |       |       |

4. Under **Retain Hdl**, select the Retain Handler that you have created.



⇒ After selecting a Retain Handler as a target, the symbols in the tree view are linked and a mapping is created. In the tree view the variables are created from the PLC under the Retain Handler and linked to the variables from the PLC instance.



An existing link is displayed with an arrow symbol.

## 8.2 Writing speed of the Retain Handler

The Retain Handler takes a certain amount of time to search for changes (delta function) in the variables and save them in the NOVRAM.

The following diagrams provide an overview of how long the Retain Handler needs to save a particular data quantity in the NOVRAM. Use the diagrams to select your task cycle time such that a particular data quantity is saved in the NOVRAM within the selected task cycle time.

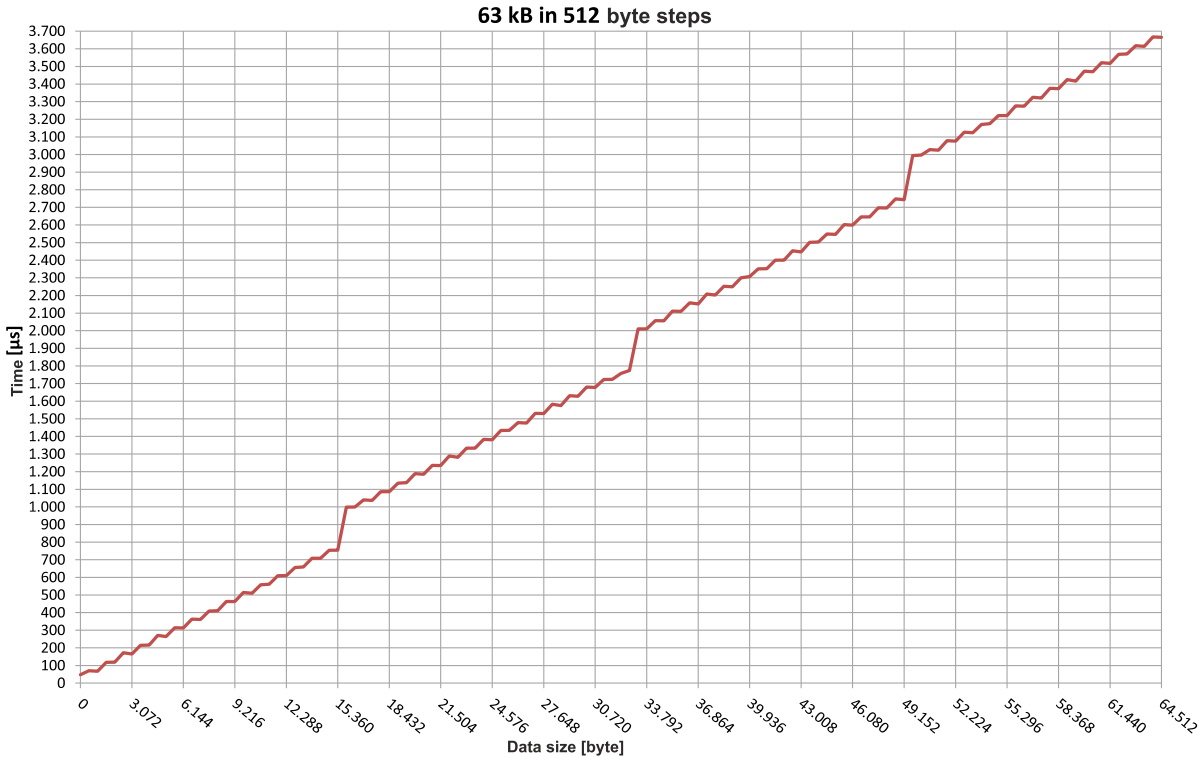


Fig. 23: Retain Handler write speed, up to 63 kB in 512 byte steps.

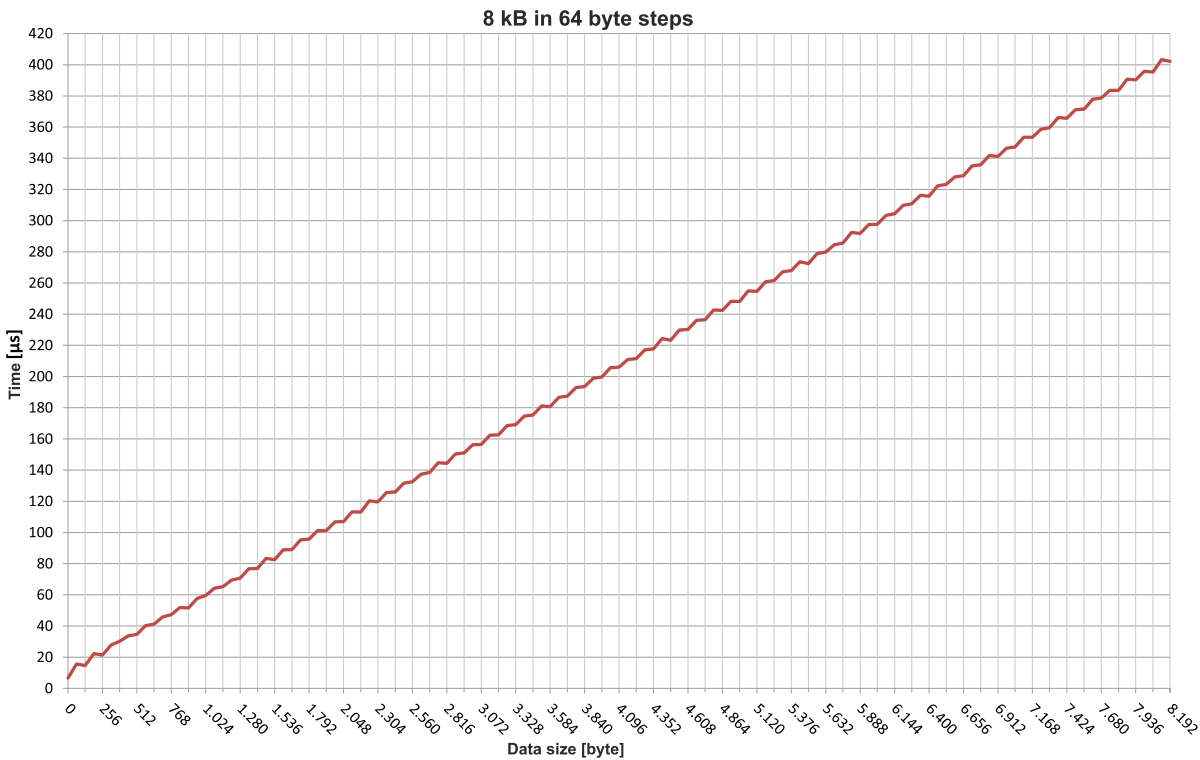


Fig. 24: Retain Handler write speed, up to 8 kB in 64 byte steps.

### 8.3 Deleting variables under the Retain Handler

If variables are deleted from the PLC, the link with the Retain Handler is cancelled. However, the variables continue to be shown under the Retain Handler and are not deleted automatically.

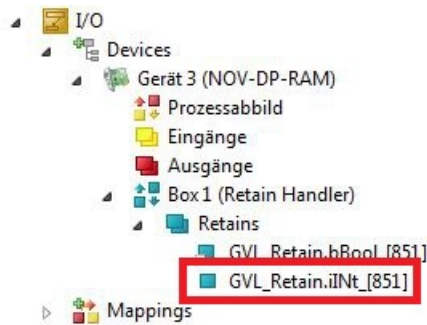
Under TwinCAT 3 the variables have to be deleted manually.

Prerequisites for this step:

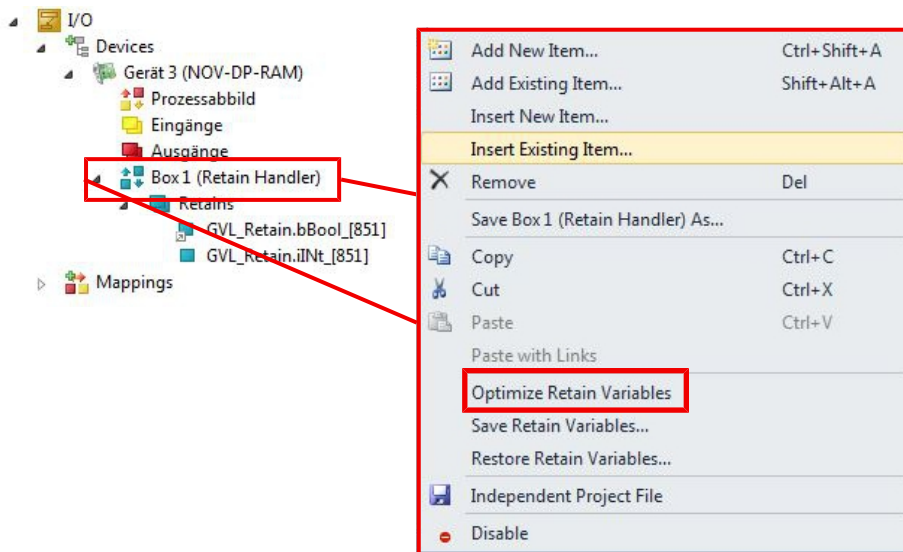
- Variables declared with VAR\_RETAIN were deleted from the PLC.

Delete the variables under the Retain Handler as follows:

1. The variable GVL\_Retain.iInt [851] under the Retain Handler is to be deleted.



2. Right-click on the **Retain Handler** in the tree view on the left.
3. In the context menu click on **Optimize Retain Variables**.



⇒ The variable under the Retain Handler is deleted.

## 9 1-second UPS (persistent variables)

**i** **Loss of data**

Use only TwinCAT to control the 1-second UPS and save only persistent data with a maximum size of 1 MB. Use beyond this may result in data loss or corrupt data.

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.

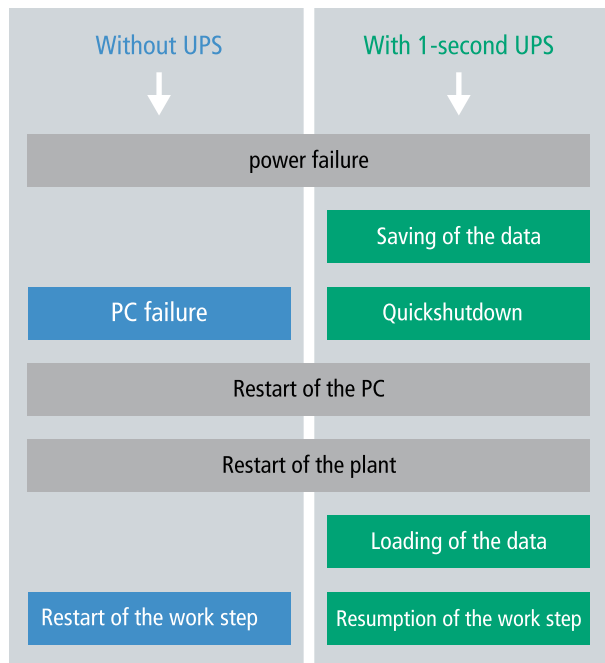


Fig. 25: Behavior of systems in the event of a power failure without and with a 1-second UPS.

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.

Table 24: Storage location and names of the files depending on the TwinCAT version.

| Development environment | File path              | File name  |
|-------------------------|------------------------|--|
| TwinCAT 2               | \\TwinCat\Boot\        | TCPLC_T_x.wbp<br>TCPLC_T_x.wb~ (backup)<br>The x in the file name stands for the number of the runtime system.             |
| TwinCAT 3               | \\TwinCat\3.1\Boot\Plc | Port_85x.bootdata<br>Port_85x.bootdata-old (backup)<br>The x in the file name stands for the number of the runtime system. |

## Configuration of the 1-second UPS

- In the case of the CX5110-01xx-9020, check whether the 1-second UPS is activated or deactivated in the BIOS (see: [BIOS settings](#) [▶ 56]).
- Declare important data such as counter values in the PLC as VAR PERSISTENT. Then call the function block FB\_S\_UPS\_BAPI cyclically in TwinCAT in order to control the 1-second UPS (see: [FB\\_S\\_UPS\\_BAPI](#) [▶ 57]).
- Select the mode in the function block in order to specify what should happen in the case of a power failure. Specify, for example, whether persistent data are saved and a quick shutdown is executed (see: [Data types](#) [▶ 59]).
- You can then check the validity of the variables and monitor whether the persistent variables are loaded without error (see: [Checking the validity of the variables](#) [▶ 60]).

## Saving and loading persistent data

The persistent data are saved in the Port\_85x.bootdata file on the memory card. On starting the PLC the Port\_85x.bootdata file is loaded from the memory 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_BAPI.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** whether the backup file is to be used or not.

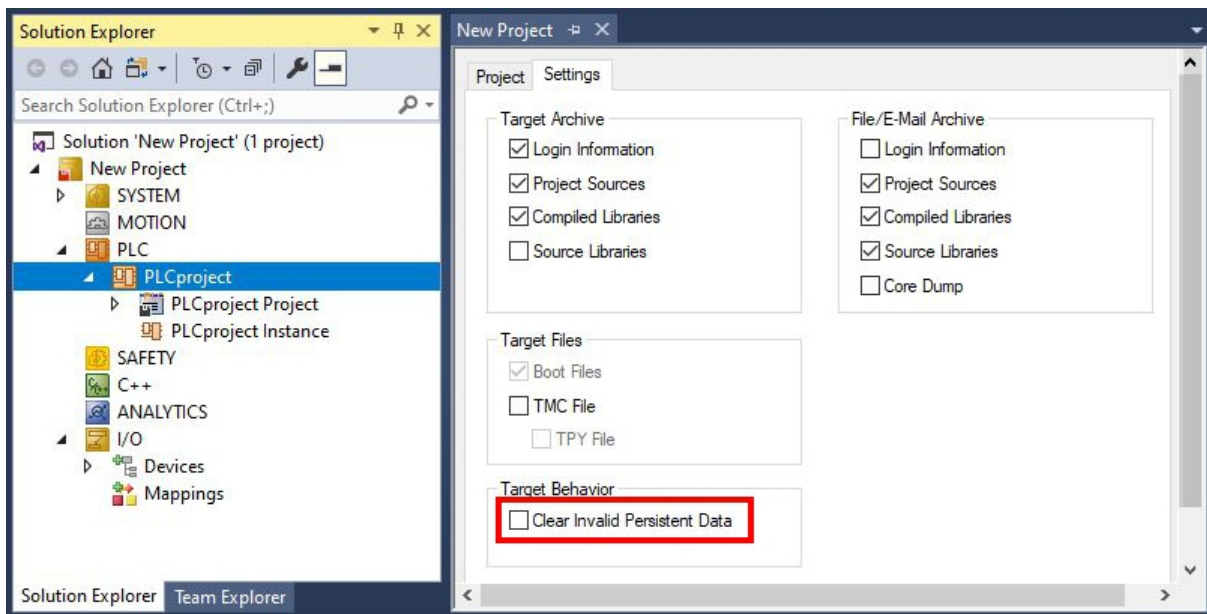



Fig. 26: Loading a backup of the persistent data. Settings in TwinCAT 3.

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

#### Documents about this

 [ups\\_example.pro \(Resources/pro/1937303563.pro\)](#)

## 9.1 BIOS settings

The 1-second UPS can be switched on or off via the BIOS. The parameters of the 1-second UPS are displayed in the following menu and can be adjusted if necessary:

**Advanced > Power Controller Options**



|  |                      |   |
|--|----------------------|---|
| Advanced                                     |                      |   |
| Bootloader version                           | 1.00-23              | Enables/disables the UPS  |
| Firmware version                             | 1.00-77              |   |
| Mainboard serial no                          | 120003414250178      |   |
| Mainboard Prod. Date (Week.Year)             | 44.14                |   |
| Mainboard BootCount                          | 4711                 |   |
| Mainboard operation time                     | 1224 min (20 h)      |   |
| Voltage (Min/Max)                            | 5.00 V / 5.20 V      |   |
| Temperature (Min/Max)                        | 15 °C / 63 °C        |   |
|  |                      |   |
| USB-Port voltage                             | [Off in S3-5]        |   |
| Watchdog timer mode                          | [Compatibility mode] |   |
| 1-second Uninterruptable Power Supply (SUPS) |                      | → ←: Select Screen<br>↑ ↓: Select Item<br>Enter: Select<br>+/-: Change Options<br>F1: General Help<br>F2: Previous Values<br>F3: Optimized Defaults<br>F4: Save & Exit<br>ESC: Quit |
| <b>SUPS Enable</b>                           | <b>[Enable]</b>      |   |
| Hold Usb                                     | [Enable]             |   |
| Delay  | 0                    |   |
|  |                      |   |
| SUPS Firmware version                        | 1.09                 |   |
| Current Power source                         | On Line              |   |
| Battery load level                           | 100%                 |   |
| Powerfail counter                            | 42                   |   |
|  |                      |   |

**SUPS Enable**

Options: Enable / Disable  
 Switches the 1-second UPS on or off.

**Hold USB**

Options: Enable / Disable  
 Switches off the power supply for the USB ports in UPS mode.

**Delay**

Options: 0...255 seconds  
 Start delay with which the 1-second UPS is charged.

**SUPS Firmware version**

Firmware version

**Current Power source**

Status of the power supply: On Line / Battery

**Battery load level**

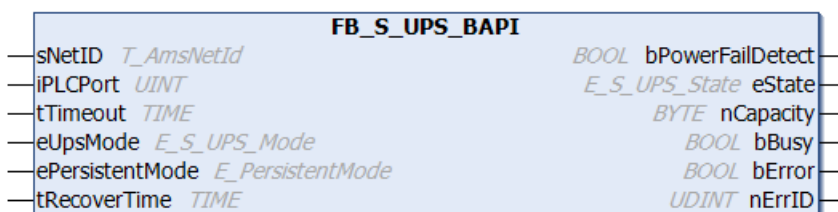
Charge state in percent (n% cap. (n={0...100}) describes the capacity of the 1-second UPS)

**Powerfail counter**

Number of voltage failures

## 9.2 FB\_S\_UPS\_BAPI

|   |
|---|
| <b>NOTICE</b>   |
| <p><b>Loss of data</b></p> <p>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.</p> |



The function block FB\_S\_UPS\_BAPI can be used on devices with 1-second UPS and with BIOS-API from version v1.15, in order to control the 1-second UPS from the PLC.

When the function block is first called, the data for accessing the 1-second UPS are determined via BIOS-API. This process takes several cycles. This is followed by cyclic testing for power failure. When the persistent data are written next, the access data for the PLC are saved persistently, so that during subsequent boot operations the check for power failures can take place immediately after the PLC start.

In the event of a power failure the charge state of the 1-second UPS is checked every 50 ms, every 200 ms if voltage is present and the capacity is less than 90%, and every second if voltage is present and the capacity is more than 90%. This also takes place via BIOS-API access.

In the event of a power failure the function block FB\_S\_UPS\_BAPI can be used to save the persistent data and/or execute a quick shutdown, depending on the selected mode. The default input values of the FB\_S\_UPS\_BAPI should be retained.

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.

Irrespective of the mode and irrespective of whether data were saved or the quick shutdown was executed, the 1-second UPS switches off the mainboard after the discharging of the capacitors.

### 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).

### Inputs

```

VAR_INPUT
  sNetID      : T_AmsNetId:= ''; (* '' = local netid *)
  iPLCPort    : UINT; (* 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

```

| Name            | Type             | Description  |
|-----------------|------------------|--|
| sNetID          | T_AmsNetId       | AmsNetID of the controller   |
| iPLCPort        | UINT             | Port number of the PLC runtime system (851 for the first PLC runtime system, 852 for the second PLC runtime system, etc.). If you do not specify a port number, the function block then automatically determines the port of the PLC runtime system. |
| tTimeout        | TIME             | Timeout for writing the persistent data or the quick shutdown  |
| eUpsMode        | E_S_UPS_Mode     | 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.       |
| ePersistentMode | E_PersistentMode | Mode for writing the persistent data. Default value is SPDM_2PASS.   |
| tRecoverTime    | TIME             | Time after which the UPS reverts to the PowerOK status in the event of UPS modes without shutdown. tRecoverTime must be somewhat longer than the maximum holding time of the UPS in order to ensure that the capacitors are fully charged.           |

 **Outputs**

```
VAR_OUTPUT
  bPowerFailDetect : BOOL; (* TRUE while powerfailure is detected *)
  eState           : E_S_UPS_State; (* current ups state *)
  nCapacity        : BYTE; (* actual capacity of UPS *)
  bBusy            : BOOL; (* TRUE: function block is busy *)
  bError           : BOOL; (* FALSE: function block has error *)
  nErrID           : UDINT; (* FB error ID *)
END_VAR
```

| Name             | Type          | Description  |
|------------------|---------------|--|
| bPowerFailDetect | BOOL          | TRUE during power failure. FALSE if the supply voltage is present. |
| eState           | E_S_UPS_State | Internal state of the function block                               |
| nCapacity        | BYTE          | Current charge state of the capacitors in percent (0..100%)        |
| bBusy            | BOOL          | TRUE, as long as the function block is active.                     |
| bError           | BOOL          | FALSE if an error has occurred.                                    |
| nErrID           | UDINT         | Error number   |

**Requirements**

| Development environment | Target platform                                | PLC libraries to include |
|-------------------------|--|--------------------------|
| TwinCAT v3.1 B4020.32   | Platforms that support the BIOS API from v1.15 | Tc2_SUPS                 |

## 9.3 Data types

### E\_S\_UPS\_Mode

With the mode selected in the function block you can specify what should happen in the case of a power failure.

```
eSUPS_WrPersistData_Shutdown: Writing of persistent data and then a QuickShutdown
eSUPS_WrPersistData_NoShutdown: Only writing of the persistent data (no QuickShutdown)
eSUPS_ImmediateShutdown: Only QuickShutdown (no writing of persistent data)
eSUPS_CheckPowerStatus: Only check status (neither writing of persistent data nor a QuickShutdown)
```

## E\_S\_UPS\_State

The internal state of the function block can be read with E\_S\_UPS\_State.

```
eSUPS_PowerOK:
in all modes: Power supply is OK

eSUPS_PowerFailure:
in all modes: Power supply is faulty (only shown for one PLC cycle)

eSUPS_WritePersistentData:
in mode eSUPS_WrPersistData_Shutdown: Writing of persistent data is active
in mode eSUPS_WrPersistData_NoShutdown: Writing of persistent data is active

eSUPS_QuickShutdown:
in mode eSUPS_WrPersistData_Shutdown: QuickShutdown ist active
in Mode eSUPS_ImmediateShutdown: QuickShutdown is active

eSUPS_WaitForRecover:
in mode eSUPS_WrPersistData_NoShutdown: Wait for the reestablishment of the power supply
in mode eSUPS_CheckPowerStatus: Wait for the reestablishment of the power supply

eSUPS_WaitForPowerOFF:
in mode eSUPS_WrPersistData_Shutdown: Wait for switching off of the PC by the UPS
in mode eSUPS_ImmediateShutdown: Wait for switching off of the PC by the UPS
```

## 9.4 Checking the validity of the variables

For TwinCAT 2 the implicit structure Systeminfotype.bootDataFlags can be read in order to determine the validity of the persistent data (see: [SYSTEMINFOTYPE \[► 60\]](#)).

For TwinCAT 3 the implicit variables PlcAppSystemInfo.BootDataLoaded and PlcAppSystemInfo.OldBootData are available for determining the validity of the persistent data (see: PlcAppSystemInfo).

### 9.4.1 SYSTEMINFOTYPE

```
TYPE SYSTEMINFOTYPE
STRUCT
runTimeNo :BYTE;
projectName :STRING(32);
numberOfTasks :BYTE;
onlineChangeCount :UINT;
bootDataFlags :BYTE;
systemStateFlags :WORD;
END_STRUCT
END_TYPE
```

**runTimeNo:** specifies the number of the runtime system (1..4).

**projectName:** project name as STRING.

**numberOfTasks:** number of tasks contained in the runtime system (max. 4).

**onlineChangeCount:** number of online changes since the last complete download.

**bootDataFlags:** State of the boot data (RETAIN and PERSISTENT) after loading. The upper four bits indicate the state of the persistent data, while the lower four bits indicate the state of the retain data.

| Bit number | Description  |
|------------|--|
| 0          | RETAIN variables: LOADED (without error)   |
| 1          | RETAIN variables: INVALID (the back-up copy was loaded, since no valid data was present)             |
| 2          | RETAIN variables: REQUESTED (RETAIN variables should be loaded, a setting in TwinCAT System Control) |
| 3          | reserved   |
| 4          | PERSISTENT variables: LOADED (without error)   |
| 5          | PERSISTENT variables: INVALID (the back-up copy was loaded, since no valid data was present)         |
| 6          | reserved   |
| 7          | reserved   |

**systemStateFlags** : Reserved.

When shutting TwinCAT down the PERSISTENT and RETAIN data is written into two files on the hard disk. The path can be specified in TwinCAT System Control by means of the TwinCAT system properties (PLC tab). The standard setting is "<Drive>:\TwinCAT\Boot". The files all have a fixed name with fixed extensions:

| File name     | Description  |
|---------------|--|
| TCPLC_P_x.wbp | Boot project (x = number of the run-time system)                           |
| TCPLC_S_x.wbp | Packed source code (x = number of the runtime system)                      |
| TCPLC_R_x.wbp | RETAIN variables (x = number of the runtime system)                        |
| TCPLC_T_x.wbp | PERSISTENT variables (x = number of the runtime system)                    |
| TCPLC_R_x.wb~ | Backup copy of the RETAIN variables (x = number of the runtime system)     |
| TCPLC_T_x.wb~ | Backup copy of the PERSISTENT variables (x = number of the runtime system) |

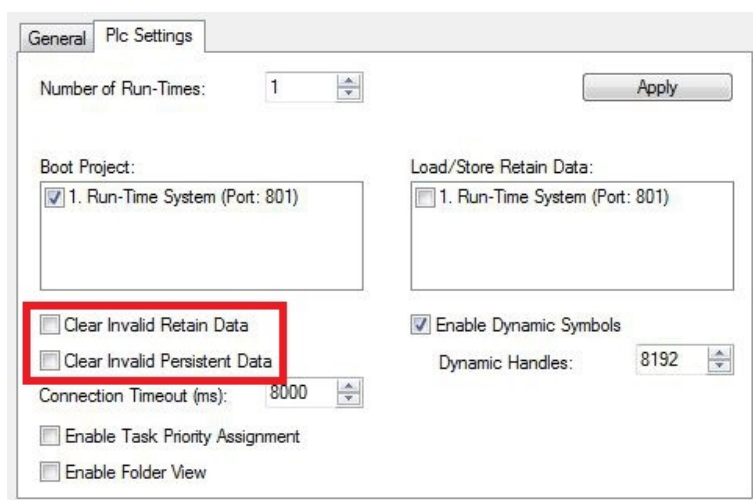
If the persistent or retain variables are not loaded, e.g. because they are invalid, the backup file is loaded by default. In that case bit 1 of the bootDataFlags (for the RETAIN variables) in the PLC and/or bit 5 (for the PERSISTENT variables) is set.

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). If the backup file is to be deleted, the value of "ClearInvalidRetainData" or "ClearInvalidPersistentData" must be set to 1 in the registry under:

```
[HKEY_LOCAL_MACHINE\SOFTWARE\Beckhoff\TwinCAT\Plc]
"ClearInvalidRetainData"=dword:00000000
"ClearInvalidPersistentData"=dword:00000000
```

the value of "ClearInvalidRetainData" or of "ClearInvalidPersistentData" must be set to 1.

Whether the backup file is to be used can also be set in the TwinCAT System Manager in the tree structure on the left under **PLC > PLC Settings**:



The backup files are deleted if the option **Clear Invalid Retain Data** or **Clear Invalid Persistent Data** is set in the System Manager. Corresponds to registry entry 1.

| Development environment       | Target platform | PLC libraries to be linked |
|-------------------------------|-----------------|----------------------------|
| TwinCAT v2.7.0                | PC or CX (x86)  | PLCSystem.Lib              |
| TwinCAT v2.8.0                | PC or CX (x86)  | TcSystem.Lib               |
| TwinCAT v2.10.0 Build >= 1301 | CX (ARM)        | TcSystem.Lib               |

## 9.4.2 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;

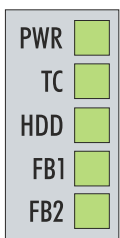
  AppName       : STRING(63);
  ProjectName   : STRING(63);
END_STRUCT
END_TYPE

```

|                           |   |
|---------------------------|---|
| <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   |

# 10 Error handling and diagnostics

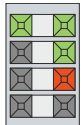
## 10.1 Diagnostic LEDs

| Display   | LED | Meaning  |
|---|-----|--|
|  | PWR | Power supply<br>The power LED lights green if the device is connected to a power supply unit and the unit is switched on.  |
|   | TC  | Bootloader is started and runs without errors (the colors red and yellow light up for one second).<br><br>TwinCAT status LED<br>TwinCAT is in Run mode (green)<br>TwinCAT is in Stop mode (red)<br>TwinCAT is in Config mode (blue)<br><br>Error or crash of the PLC (yellow). Applies only to TwinCAT 3 |
|   | HDD | Read/Write CFast card<br>(red) indicates that access to the CFast card is in progress.   |
|   | FB1 | Status LED1 for fieldbus (the function is described under the fieldbus interface)  |
|   | FB2 | Status LED2 for fieldbus (the function is described under the fieldbus interface)  |

### 10.1.1 K-bus

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.

Table 25: Diagnostic LEDs in K-Bus mode.

| 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 26: 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 27: 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.

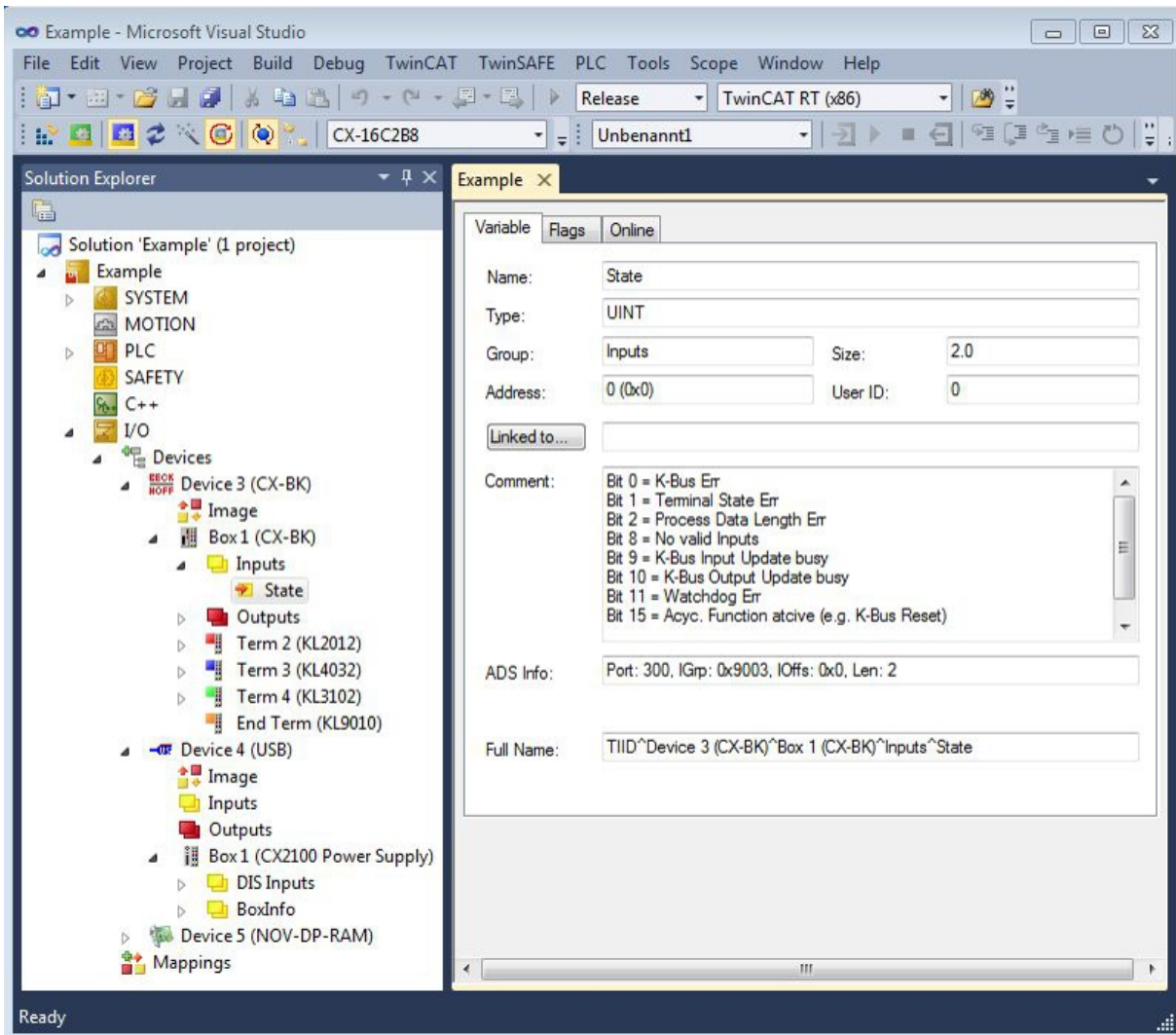


Fig. 27: Status variable for error handling and diagnostics under TwinCAT.

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 28: Description of the State variable values.

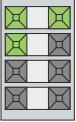
| Bit    | Description   |
|--------|---|
| Bit 0  | K-bus error.  |
| Bit 1  | Terminal configuration has changed since the start. |
| Bit 2  | Process image lengths do not match.                 |
| Bit 8  | (still) no valid inputs.                            |
| Bit 9  | K-bus input update not yet 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).

## 10.1.2 E-bus

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.

Table 29: Diagnostic LEDs in K-Bus mode.

| Display  | LED     | Meaning   |                      |
|--|---------|---|----------------------|
| Us 24 V  Up 24 V<br>L/A | 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.  |                      |

## 10.2 Faults

Please also refer to the Safety instructions section.

### Possible faults and their correction

| Fault   | Cause  | Measures  |
|---|--|---|
| no function after the embedded PC has been switched on                  | no power supply for the embedded PC<br>other causes  | 1. Check the fuse<br>2. Measure the supply voltage, check the connection, call Beckhoff support |
| Embedded PC does not boot fully   | Hard disk damaged (e.g. due to switching off while software is running), incorrect setup, other causes | Check setup Call Beckhoff Support   |
| Computer boots, software starts, but control does not operate correctly | Cause of the fault is either in the software or in parts of the plant outside the embedded PC          | Call the manufacturer of the machine or the software.   |
| Error on µSD card access  | Faulty microSD card, faulty slot   | Use a different microSD card to check the slot. Call Beckhoff Support                           |
| Embedded PC only works partially or temporarily                         | Defective components in the embedded PC  | Call Beckhoff support   |

Please make a note of the following information **before** contacting Beckhoff service or support:

1. Precise device ID: CXxxxx-xxxx
2. Serial number/BTN
3. Hardware version
4. any interfaces (N030, N031, B110, ...)
5. TwinCAT version used
6. Any components / software used

The quickest response will come from support / service in your country. Therefore please contact your regional contact. For details please refer to our website at <https://www.beckhoff.com> or ask your distribution partner.

# 11 Care and maintenance

## 11.1 Replace the battery

### NOTICE

#### 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 CR2032 battery (3 V, 225 mAh) is used in the Embedded PC.

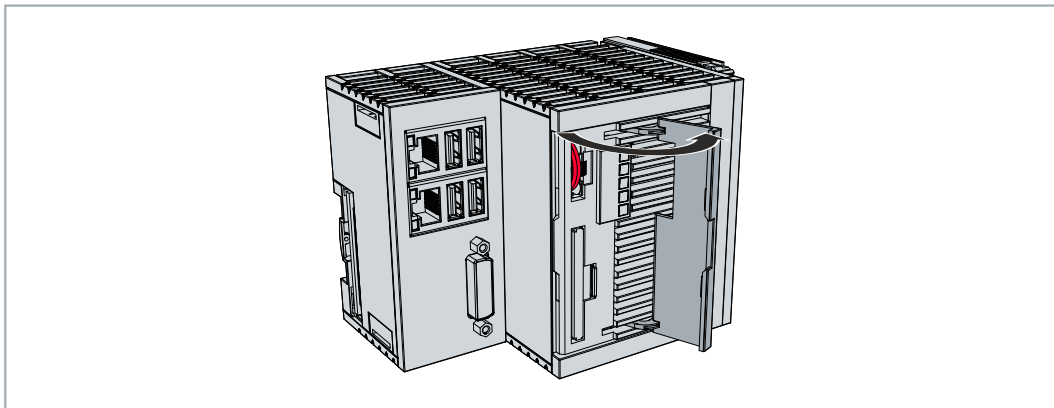
The battery compartment is below the front flap. The battery stores the time and date. The time and date are reset if the battery is removed. Be aware of this behavior for your hardware and software configuration and reset the time and date in the BIOS after a battery change. All other BIOS settings remain unchanged and are retained.

Requirements:

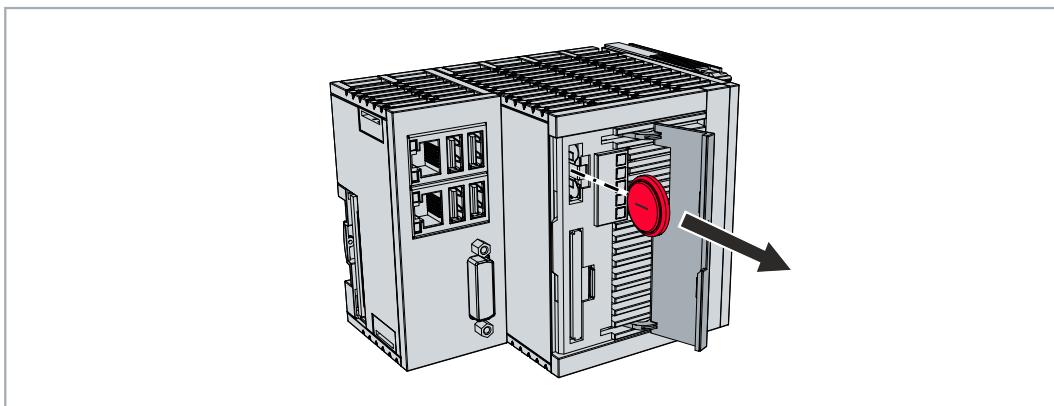
- The Embedded PC is switched off.

**Replace the battery as follows:**

1. Open the front flap.



2. Carefully pull the battery from the bracket.



3. Push the new battery into the battery compartment. The negative pole points to the left towards the DVI-I interface.

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

## 11.2 Cleaning the Embedded PC

### ⚠ CAUTION

#### **Risk of electric shock**

Live devices or parts can cause electric shocks. Disconnect the Embedded PC from the power supply before cleaning.

Clean only the housing of the Embedded PC. Use a soft, moist cleaning cloth for this. Make sure that the ventilation slots of the device are always free and do not clog up.

The following cleaning agents and materials are unsuitable and may cause damage:

- corrosive cleaning agents
- solvents
- scouring agents
- hard objects

## 12 Decommissioning

### 12.1 Removing cables

#### NOTICE

##### Electrical voltage

If the power supply is switched on during dismantling, this can lead to damage to the Embedded PCs. Switch off the power supply for the Embedded PCs during dismantling.

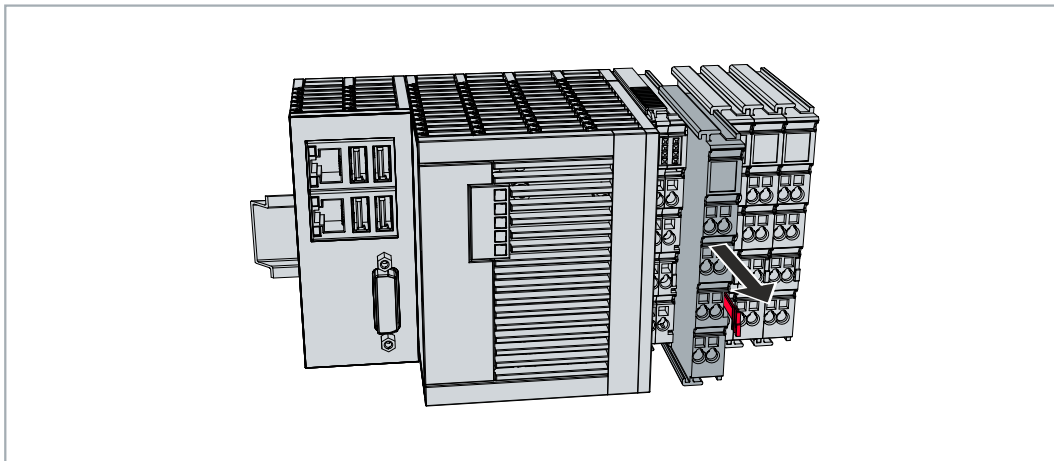
Before dismantling the Embedded PC, shut down the Embedded PC and switch off the power supply. Only then can you remove all the cables. Also remove all cables from the first terminal after the power supply terminal.

Requirements:

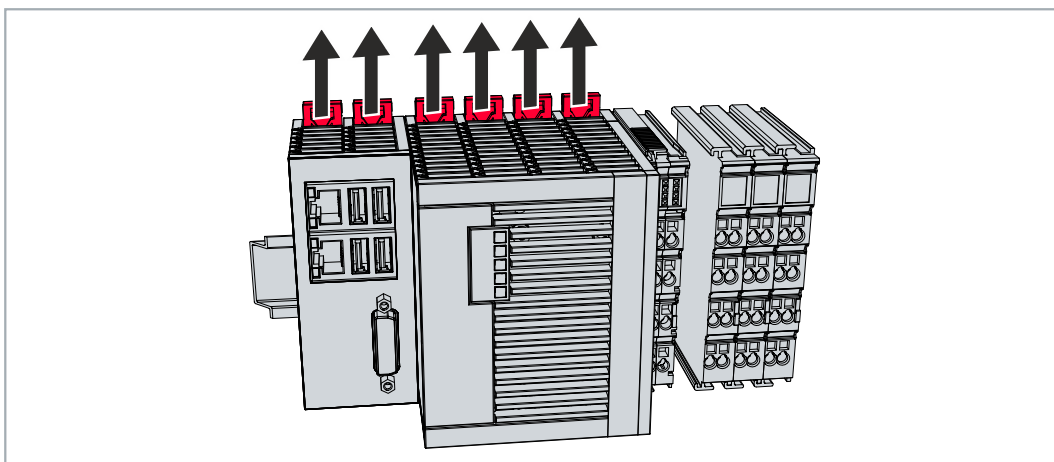
- Terminate your software and shut down the Embedded PC.
- Switch off the power supply.

**Remove the cables as follows:**

1. Remove the cabling from the Embedded PC.
2. Remove the wiring from the first terminal next to the power supply terminal.
3. Pull the orange strap to remove the first terminal after the power supply terminal by pulling it forward.



⇒ In the next step the Embedded PC can be removed from the DIN rail and dismantled.



### 12.2 Dismantling the Embedded PC

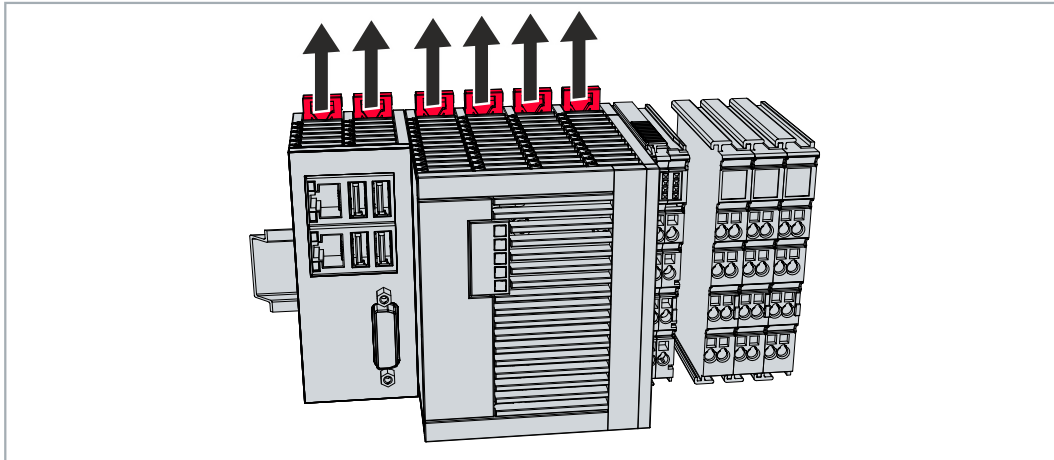
This chapter explains how to dismantle the Embedded PC and remove it from the DIN rail.

Requirements:

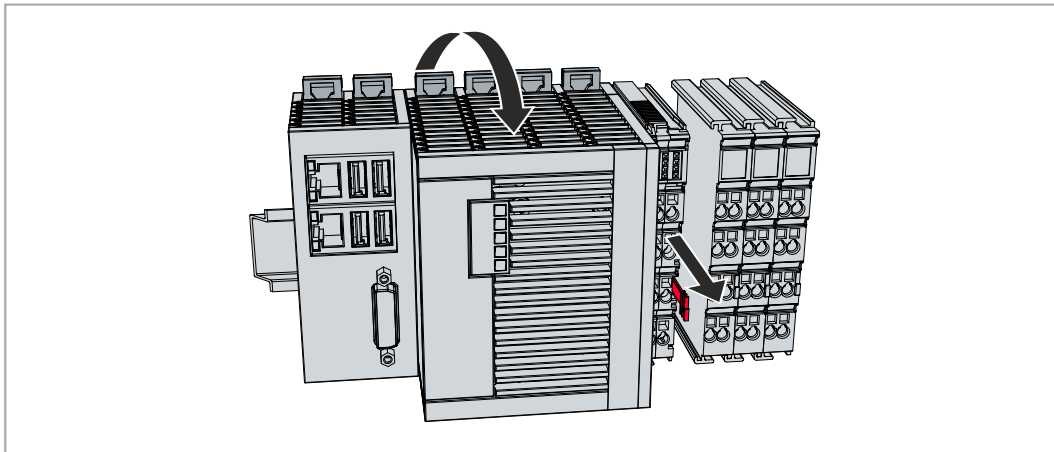
- All cables were removed from the Embedded PC.

**Dismantle the Embedded PC as follows:**

1. Release the DIN rail mounting by pushing the latches outwards with a screwdriver.



2. Pull the orange strap on the power supply terminal and gently remove the device from the DIN rail.



⇒ You have removed the Embedded PC successfully.

**Disposal**

The device must be fully dismantled in order to dispose of it. Electronic components must be disposed of according to national electronic waste regulations.

## 13 Technical data

Table 30: Technical data, dimensions and weights.

|                        | <b>CX5110-01xx-9020</b> |
|------------------------|-------------------------|
| Dimensions (W x H x D) | 102 mm x 100 mm x 92 mm |
| Weight                 | approx. 760 g           |

Table 31: Technical data, general data.

| <b>Technical data</b>  | <b>CX5110-01xx-9020</b>   |
|------------------------|---|
| Processor              | Intel Atom® E3815 1.20 GHz  |
| Number of cores        | 1   |
| Main memory            | 2 GB DDR3-RAM (not extendable)  |
| Flash memory           | Slot for CFast card and MicroSD card, 512 MB MicroSD card included    |
| Persistent memory      | 128 kB NOVRAM integrated  |
| Power supply           | 24 V DC (-15 %/+20 %)   |
| Max. power consumption | 10 W  |
| Dielectric strength    | 500 V (supply / internal electronics)                                 |
| Operating system       | Microsoft Windows Embedded Compact 7                                  |
| Control software       | TwinCAT 2 Runtime<br>TwinCAT 3 Runtime (XAR)                          |
| Diagnostics LED        | 1 x power, 1 x TC status, 1 x flash access, 2 x bus status            |
| Clock                  | Internal battery-backed clock for time and date (battery replaceable) |
| Approvals              | CE, UL  |

Table 32: Technical data, I/O terminals.

| <b>Technical data</b>            | <b>Description</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 load      | max. 10 A   |
| Process data on the K-bus        | max. 2048 bytes input and 2048 bytes output                       |
| max. number of terminals (K-bus) | 64 (255 with K-bus extension)                                     |
| max. number of terminals (E-bus) | up to 65534 terminals.  |



Table 33: Technical data, environmental conditions.

| Technical data                       | Description  |
|--------------------------------------|--|
| Ambient temperature during operation | -25 °C ... +60 °C  |
| Ambient temperature during storage   | -40 °C ... +85 °C<br>see notes under: <a href="#">Transport and storage</a> [▶ 10]   |
| Relative humidity                    | 95 % no condensation   |
| Vibration resistance                 | 10 frequency sweeps, in 3-axis<br>10 Hz < f < 58.1 Hz displacement 0.15 mm, constant amplitude<br>58.1 Hz < f < 500 Hz acceleration 2 g (~ 20 m/s <sup>2</sup> ), constant amplitude<br>conforms to EN 60068-2-6 |
| Shock resistance                     | 1000 shocks in each direction, in 3 axes<br>15 g, 11 ms<br>conforms to EN 60068-2-27   |
| EMC immunity                         | conforms to EN 61000-6-2   |
| EMC emission                         | conforms to EN 61000-6-4   |
| Protection rating                    | IP20   |

Table 34: Technical data, graphic specifications.

| Technical data       | CX5110-01xx-9020       |
|----------------------|------------------------|
| Processor graphics   | Intel® HD Graphics     |
| Graphic memory       | 256 MB (shared memory) |
| Base clock frequency | 400 MHz                |
| max. burst frequency | 400 MHz                |
| Shader model         | 5.0                    |
| DirectX              | 11                     |
| OpenGL               | 4.0                    |

Table 35: Technical data, interfaces.

| Technical data | Description  |
|----------------|--|
| LAN            | 2 x RJ 45, 10/100/1000 Mbit/s                                    |
| USB            | 4 x USB 2.0 each rated at 500 mA, type A                         |
| DVI-I          | Resolution on the monitor in pixels:<br>640 x 480 to 1920 x 1200 |

Table 36: Technical data, optional interfaces.

| Technical data | Description  |
|----------------|--|
| RS232          | D-sub connector, 9-pin<br>Electrical isolation 500 V |
| RS422/RS485    | D-sub connector, 9-pin<br>Electrical isolation 500 V |
| EtherCAT slave | 2 x RJ 45, EtherCAT IN and OUT<br>100 Mbaud          |
| PROFIBUS       | D-sub connector, 9-pin<br>9.6 kbaud to 12 Mbaud      |
| CANopen        | D-sub connector, 9-pin<br>10 kbaud to 1,000 kbaud    |
| PROFINET RT    | 2 x RJ-45 switches                                   |

# 14 Appendix

## 14.1 Accessories

Table 37: Options.

| Order number | Description  |
|--------------|--|
| CX5110-U900  | Option only for CX5110-01xx-9020, internal capacitive 1-second UPS for safe storage of persistent application data on the MicroSD card |

Table 38: MicroSD cards.

| Order number | Description         |
|--------------|---------------------|
| CX1900-0122  | 512 MB MicroSD card |
| CX1900-0124  | 1 GB MicroSD card   |
| CX1900-0126  | 2 GB MicroSD card   |
| CX1900-0128  | 4 GB MicroSD card   |
| CX1900-0130  | 8 GB MicroSD card   |

Table 39: CFAST cards

| Order number | Description   |
|--------------|---|
| CX2900-0026  | 20 GB CFAST card, 3D flash, extended temperature range  |
| CX2900-0038  | 40 GB CFAST card, 3D flash, extended temperature range  |
| CX2900-0040  | 80 GB CFAST card, 3D flash, extended temperature range  |
| CX2900-0042  | 160 GB CFAST card, 3D flash, extended temperature range |

Table 40: Spare battery for CX systems.

| Order number | Description   |
|--------------|---|
| CX1900-0102  | Replacement battery, suitable for CX10x0, CX50x0, CX51x0, CX5110-01xx-9020, CX52x0, CX56x0, CX90x0, CX20xx and CX8100<br>– Lithium button cell type CR2032, 3 V/225 mAh |

## 14.2 Certifications

### **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.

## 14.3 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.

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More Information:

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