



**Manual**

**CX2042, CX2062, CX2072**

**Manycore Embedded PC**

**Version: 1.0**  
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**BECKHOFF**



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# 1 Notes on the documentation

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

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

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

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

## Disclaimer

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

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

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

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## Patent Pending

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

EP1590927, EP1789857, DE102004044764, DE102007017835

with corresponding applications or registrations in various other countries.

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## 1.1 Explanation of symbols

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


### Symbols that warn of personal injury:

 <b>DANGER</b>	<b>Serious risk of injury</b> Note this warning. Hazard with high risk of death or serious injury.
 <b>WARNING</b>	<b>Risk of injury</b> Note this warning. Hazard with medium risk of death or serious injury.
 <b>CAUTION</b>	<b>Personal injuries</b> Note this warning. Hazard with a low degree of risk, which could lead to minor or moderate injury.

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

 <b>Attention</b>	<b>Damage to the devices or environment</b> Note this warning. Risk of damage to the environment and equipment.
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### Symbols indicating further information or tips:

 <b>Note</b>	<b>Tip or pointer</b> This symbol indicates information that contributes to better understanding.
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## 1.2 Related documents

This documentation contains and describes material that is relevant for the CX20x2 Embedded PC. The CX20x2 Embedded PC is part of a modular system and belongs to the CX2000 Embedded PC series. Further information on the devices of the CX2000 Embedded PC series can be found in the associated documentation. Read and follow in particular the sections on safety in this documentation.

The following important documentation can be viewed at and downloaded from the Beckhoff website:

<http://www.beckhoff.de>

Document name
CX2100-00x4 power supply unit for CX20x0

### Retaining the documentation

This documentation forms part of the Embedded PC. Keep the documentation in the immediate vicinity of the device throughout its entire service life. Ensure that personnel have access to the documentation at all times. Pass on the documentation to subsequent users, and in addition ensure that all supplementary information is included in the documentation.

## 1.3 Documentation issue status

Version	Changes
1.0	First Version

## 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 CX20x2 Embedded PC series is a modular control system, which is intended for installation on a DIN rail. The system is scalable, so that the basic PC modules, power supply units, system modules and extension modules can be assembled and installed in the control cabinet or terminal box as required.

The CX20x2 Embedded PC series is used in conjunction with Bus Terminals for recording digital and analog signals from sensors and transferring them to actuators or higher-level controllers. The CX20x2 Embedded PC series combines the worlds of Industrial PC and hardware PLC and is suitable for control tasks.

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 Embedded PC and the associated network.

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

## 2.3 Safety instructions

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



## Mounting

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

## Working with networks

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

## Working with the software

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


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

<http://infosys.beckhoff.de>

Document name
Documentation about IPC Security

### 3 Transport and storage

#### Transport

 <b>Attention</b>	<p><b>Short circuit due to moisture</b></p> <p>Moisture can form during transport in cold weather or in the event of large temperature fluctuations.</p> <p>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.</p>
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Despite the robust design of the unit, the components are sensitive to strong vibrations and impacts. During transport the Embedded PC must be protected from

- mechanical stress and
- use the original packaging.

*Table 1: Dimensions and weight of the individual modules.*

	<b>CX2042</b>	<b>CX2062</b>	<b>CX2072</b>
Dimensions (W x H x D)	204 mm x 99 mm x 91 mm		
Weight	1300 g		

#### Storage

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

## 4 Product overview

The CX2000 product family consists of individual modules, which can be assembled to form a customized Embedded PC.

The CX2000 product family consists of:

- basic CPU modules,
- CX2100 power supply units,
- system, fieldbus and extension modules,
- and the CX2900 battery pack.

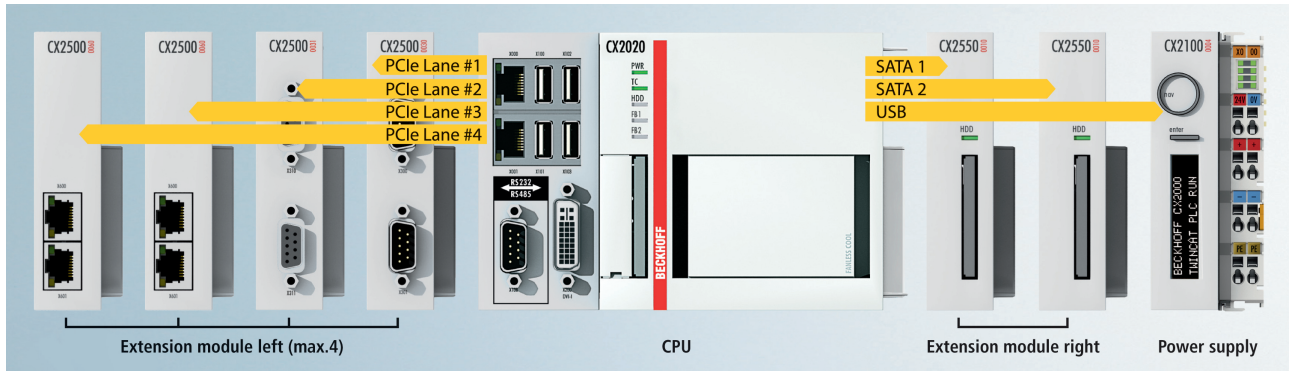


Fig. 1: Overview of the CX2000 product family with basic CPU module, power supply unit and modules.

### Basic CPU module

The basic CPU module is a fully functional PC and can be used in conjunction with a CX2100 power supply unit as the smallest possible configuration. The basic configuration of the CX20x2 Embedded PC includes:

- a CFast card slot,
- two independent Gbit Ethernet interfaces,
- four USB 3.0 interfaces,
- and a DVI-I interface.

The basic CPU module can be extended with additional interfaces or storage media, as required. Up to four system or fieldbus modules can be connected on the left-hand side of the basic CPU module. Up to four extension modules can be connected on the right-hand side between the basic CPU module and the power supply unit. Two extension modules for additional storage media (CFast card, SSD) and two extension modules for a USB extension.

Microsoft Windows 10 IoT Enterprise LTSC can be used as operating system.

The basic CPU module features 128 kB NOVRAM as internal persistent data memory and can be used as an alternative to a power supply unit with capacitive UPS or an external battery pack. In the event of a power failure, important data are stored in the NOVRAM and are available again after a restart.

The basic CPU module can be ordered ex factory with an optional interface. The optional interface cannot be retrofitted.

Table 2: Available optional interfaces for the CX20x2.

CX20x0-xxxx	Optional interfaces
CX20x0-N010	DVI-D, additional DVI-D socket for clone and extended display mode.
CX20x0-N011	DisplayPort, additional DisplayPort for clone and extended display mode
CX20x0-N030	RS232, D-sub connector, 9-pole.
CX20x0-N031	RS422/RS485, D-sub socket, 9-pole.
CX20x0-B110	EtherCAT slave, EtherCAT IN and OUT (2 x RJ45).
CX20x0-M310	PROFIBUS master, D-sub socket, 9-pole.
CX20x0-B310	PROFIBUS slave, D-sub socket, 9-pole.
CX20x0-M510	CANopen master, D-sub connector, 9-pole.
CX20x0-B510	CANopen slave, D-sub connector, 9-pole.
CX20x0-M930	PROFINET RT, controller, Ethernet (2 x RJ-45).
CX20x0-B930	PROFINET RT, device, Ethernet (2 x RJ-45 switch).

### CX2100 power supply units

The CX2100 power supply units serve the basic CPU module and all additional modules. Bus Terminals (K-bus) or EtherCAT Terminals (E-bus) can be attached on the right-hand side of the power supply units. The following power supply unit is available for the CX20x2 Embedded PC:

- CX2100-0014: E-bus/K-bus power supply unit with automatic switchover and passive ventilation.

The power supply units feature an illuminated anti-glare LC display with two rows of 16 characters each for displaying status messages. Application-specific texts can be displayed with the aid of user programs.

### System, fieldbus and extension modules

System or fieldbus modules of type CX2500-xxxx can be connected on the left-hand side of the basic CPU module. Up to four modules can be connected to the multi-pole connection on the left. Extension modules of type CX2550 can be connected on the right between the basic CPU module and the power supply unit.

### Software

In combination with the TwinCAT automation software the CX20x2 Embedded PC becomes a powerful IEC 61131-3 PLC. In conjunction with EtherCAT and TwinCAT, it is possible to implement very fast control processes in the microsecond range (XFC eXtreme Fast Control Technology). It is also possible to execute Motion Control tasks with potentially up to 256 axes. Depending on the required sampling time, several servo axes can be controlled. Even special functions such as flying saw, electronic gearbox and cam plate can be realized.

In addition to handling real-time control tasks the TwinCAT real-time kernel leaves enough time for the user interface (HMI). The high performance of the graphics core integrated in the CPU enables demanding visualizations with advanced user interfaces to be realized.

## 4.1 Configuration of the basic CPU module

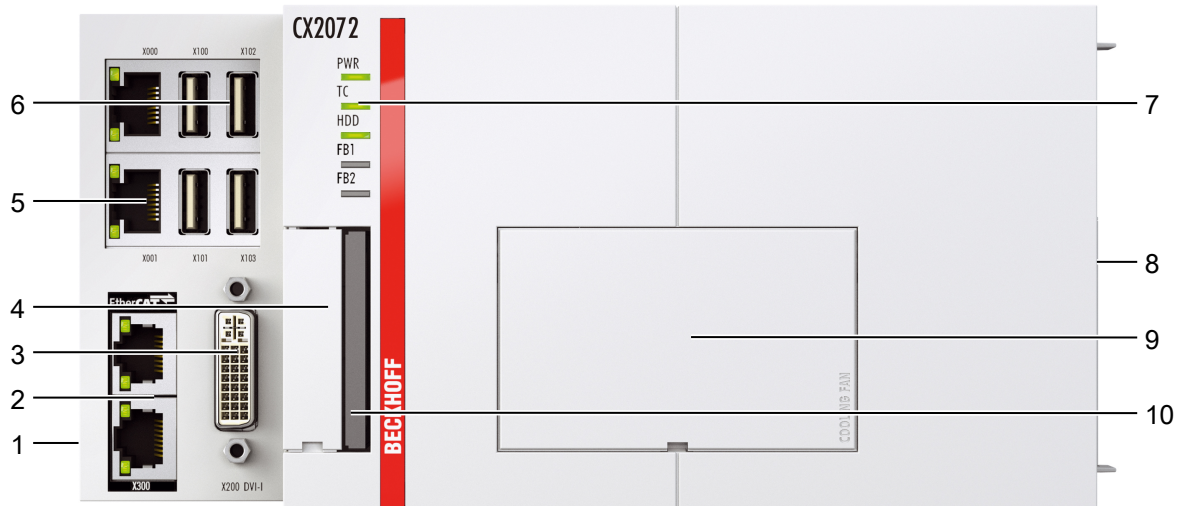


Fig. 2: Example of a CX2072 Embedded PC.

Table 3: Legend for the configuration of the basic CPU module

No.	Component	Description
1	Multi-pole connection (left)	Extension through system modules and fieldbus modules of type CX2500.
2	Optional interface <a href="#">[▶ 22]</a> (X300)	Space for interfaces such as RS232, EtherCAT, CANopen or others. The optional interface must be ordered ex factory and cannot be retrofitted retrospectively.
3	DVI-I interface <a href="#">[▶ 21]</a> (X200)	Interface for a monitor or Panel.
4	Battery compartment <a href="#">[▶ 59]</a> (under the front flap). <a href="#">[▶ 59]</a>	Power supply for the battery-backed clock for time and date.
5	RJ45 Ethernet interfaces <a href="#">[▶ 20]</a> (X000, X001).	For connecting to local networks, internet or EtherCAT.
6	USB 3.0 interfaces <a href="#">[▶ 19]</a> (X100, X101, X102, X103).	Interfaces for peripherals such as mouse, keyboard or USB memory.
7	Diagnostic LEDs <a href="#">[▶ 54]</a> .	Diagnostic LEDs for power supply, TwinCAT, CFast card and optional interface.
8	Multi-pole connection (right)	Connection for extension modules of type CX2550 and for power supply units of type CX2100.
9	Fan cartridge <a href="#">[▶ 60]</a> (under the front flap).	The CX20x2 Embedded PCs feature a fan cartridge as standard.
10	CFast card slot <a href="#">[▶ 35]</a> .	Slot for industrial CFast cards.

## 4.2 Name plate

The CX20x2 Embedded PC features a name plate on the left-hand side of the housing.

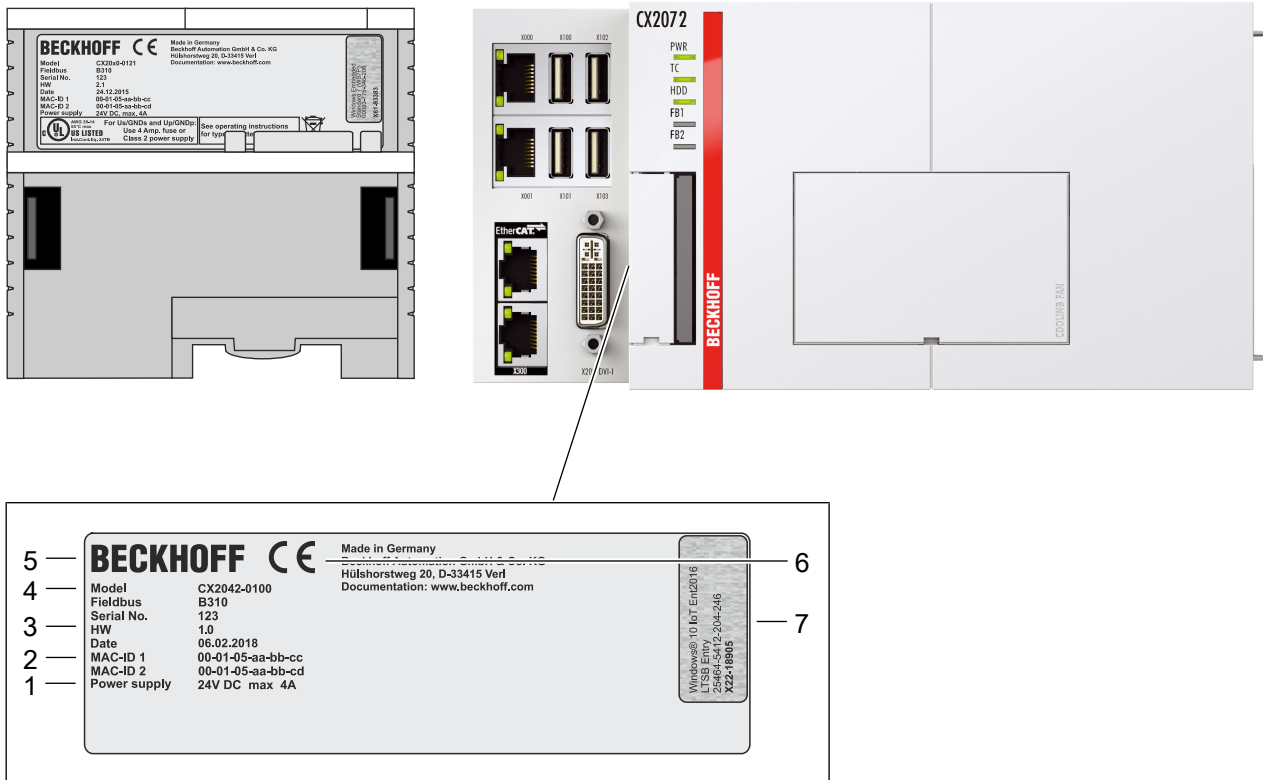
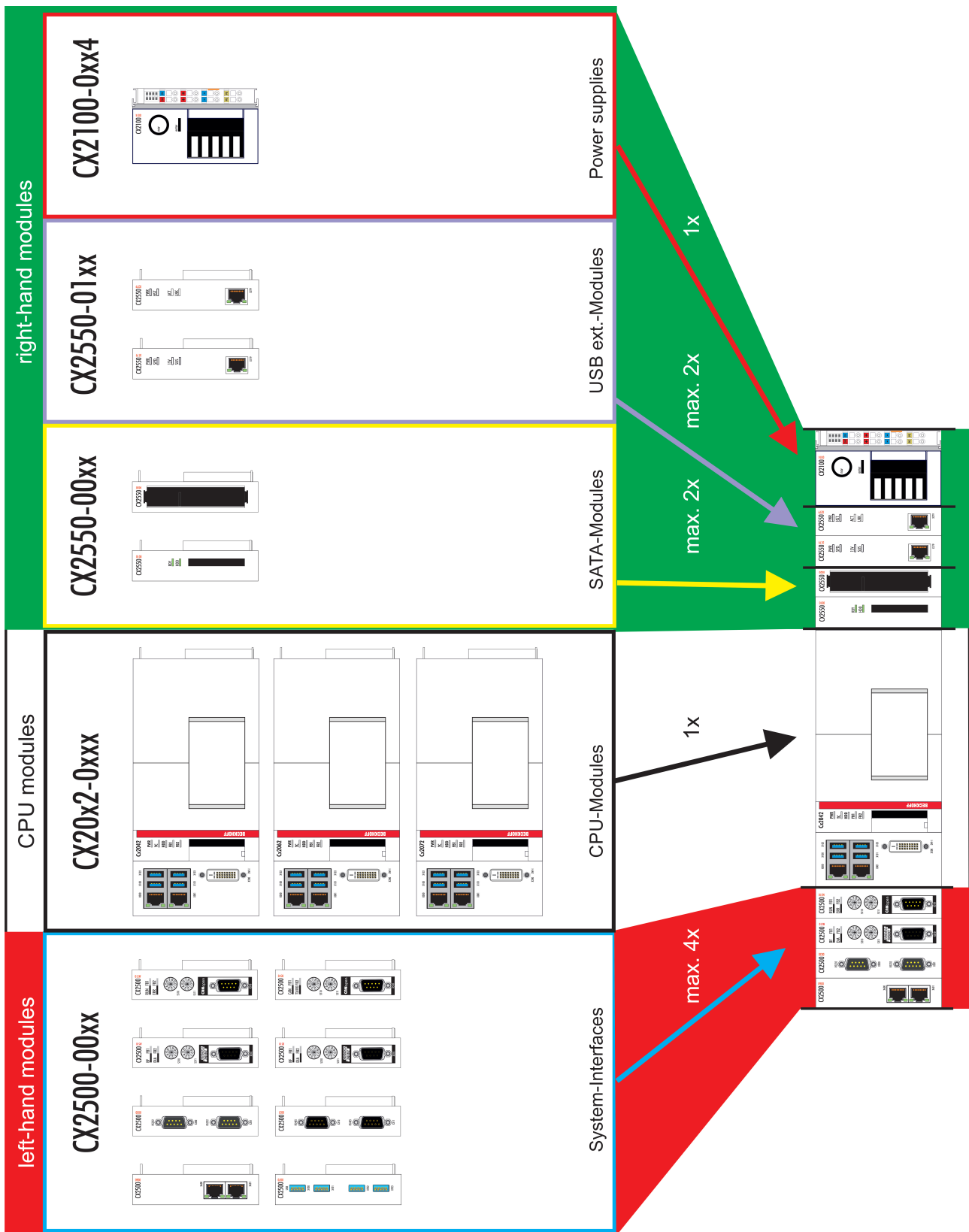


Fig. 3: CX20x2 name plate.

Table 4: Legend for the name plate.

No.	Description
1	Information on the power supply unit. 24 V DC, 4 A max.
2	MAC addresses of the integrated Ethernet ports. By default, the host name is formed from CX plus the last 3 bytes of the MAC address: for example, the MAC address: 00-01-05-aa-bb-cc results in the host name <b>CX-aabbcc</b> .
3	Information on: <ul style="list-style-type: none"> <li>• serial number,</li> <li>• hardware version</li> <li>• and date of manufacture.</li> </ul>
4	Information on the model. The last four numerals relate to the configuration of Embedded PC.
5	Manufacturer information including address.
6	CE compliant.
7	Windows license sticker (optional).

### 4.3 Module overview



## 4.4 Types

The basic CPU module can be ordered with different hardware and software options. Use this overview in conjunction with the information on the name plate to ascertain the hardware, operating system and TwinCAT version of the basic CPU module.

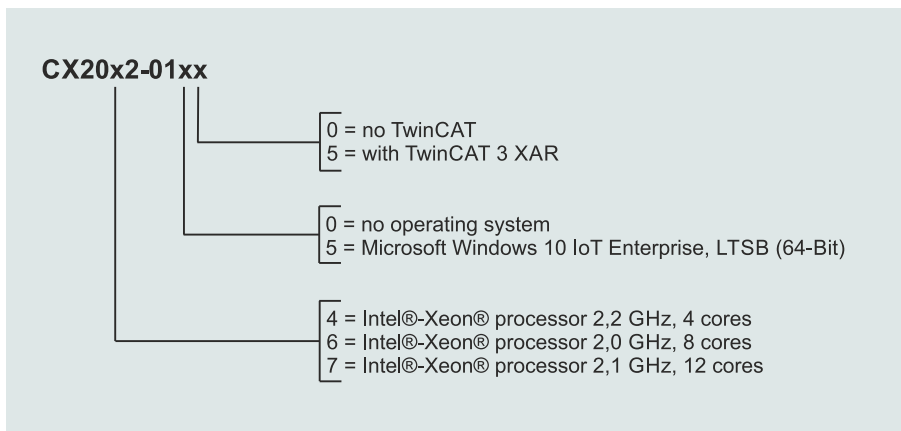


Fig. 4: Nomenclature for the basic CPU module.

The basic CPU module CX2042, CX2062 and CX2072 is available with the following software options:

Table 5: CX20x2, ordering information for software.

Module	no operating system	Windows 10 IoT Enterprise, 64-bit	no TwinCAT	TwinCAT 3 XAR
CX20x2-0100	X	-	X	-
CX20x2-0150	-	X	X	-
CX20x2-0155	-	X	-	X

An CX20x2 Embedded PC with Windows 10 IoT Enterprise LTSB 64 bit requires a CFast card with a capacity of at least 30 GB.



## 4.5 Architecture overview

The many-core CX20x2 Embedded PCs all have the same architecture, which is structured as follows:

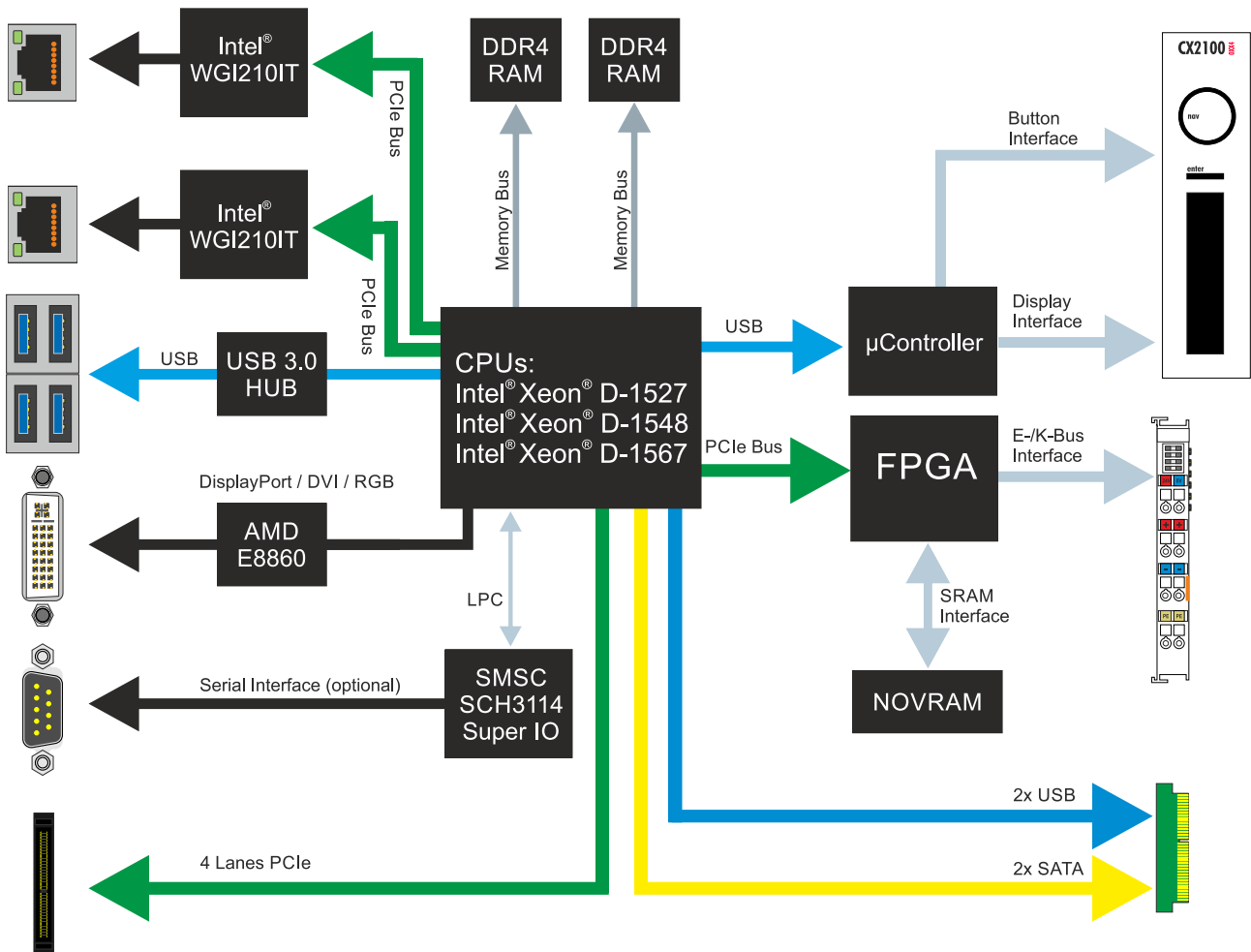


Fig. 5: CX20x0 architecture overview.

The CX20x2 Embedded PCs are based on the Broadwell microarchitecture developed by Intel. The following CPUs are used:

- Intel® Xeon® D-1527,
- Intel® Xeon® D-1548,
- and Intel® Xeon® D-1567.

In addition to the arithmetic unit, the CPU also houses the memory controller. The memory is connected directly to the memory controller. The Embedded PCs are available in three memory configurations: 8 GB, 16 GB and 32 GB DDR4 RAM. The memory configuration must be ordered from the factory and is not expandable.

The CX20x2 Embedded PCs have a graphics card with a separate 2 GB RAM memory. This separation of CPU RAM and GPU RAM prevents inhibitory influences between the two processing units.

The CX20x2 Embedded PCs feature all common interfaces:

- 4 x USB 3.0
- 1x USB 2.0 internal (power supply unit control button / display).
- DVI-I interface. Second interface optional: DVI-D or DisplayPort.
- 1 PCIe lane for each of the two Intel® WGI210IT Gigabit Ethernet controllers.
- LPC interface for super I/O controller for serial interface (CX20x0-N03x).
- 4 PCIe lanes via the multi-pole connection (left).

- 1 PCIe to FPGA for K-/E-bus and NOVRAM.
- 2x SATA internal via the multi-pole connection (right).
- 2x USB internal via the multi-pole connection (right).

The interfaces (USB, DVI, and LAN) are standard interfaces. Devices that meet the corresponding standard can be connected to and operated at these interfaces. A VGA monitor can be connected to the DVI-I interface with an adapter.

Intel® WGI210IT Gigabit Ethernet controllers are used as network controllers. There are two independent LAN interfaces. Both LAN interfaces are gigabit-capable and support jumbo frames.

## 5 Description of the interfaces

### 5.1 USB 3.0 interfaces (X100, X101, X102, X103)

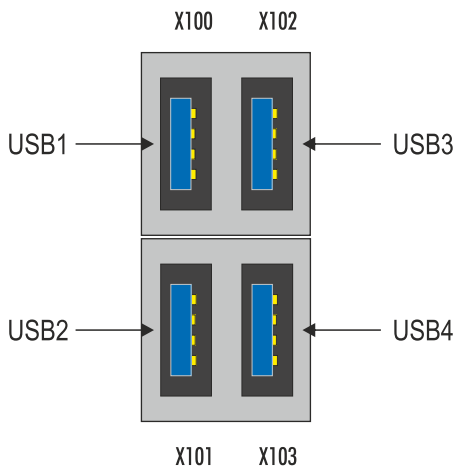


Fig. 6: USB 3.0 interfaces X100, X101, X102, X103.

The Embedded PC has four independent USB 3.0 interfaces for connecting keyboards, mice, touchscreens and other input or data storage devices.

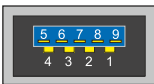


Fig. 7: USB 3.0 interface, pin numbering.

Note the power consumption of the individual devices. Each interface is limited to 900 mA. The USB 3.0 interface is of type A and corresponds to the USB 3.0 specification.

Table 6: USB 3.0 interfaces (X100, X101, X102, X103), connection.

Pin	Pinout	Description
1	VCC (VBUS)	5 V for USBX
2	D-	Minus data channel USBX
3	D+	Plus data channel USBX
4	GND	Ground
5	StdA_SSRX-	SuperSpeed Receiver-
6	StdA_SSRX+	SuperSpeed Receiver+
7	GND_DRAIN	Ground
8	StdA_SSTX-	SuperSpeed Transmitter-
9	StdA_SSTX+	SuperSpeed Transmitter+
Shell	Shield	Drain Wire

## 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 delivery state the Ethernet interfaces (X000, X001) are configured for EtherCAT communication.

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

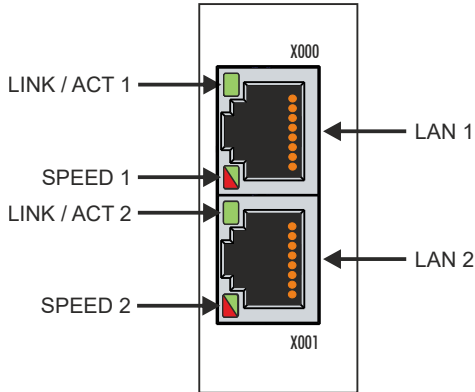


Fig. 8: Ethernet interface X000, X001.

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 is green. The LED flashes when data transfer is in progress.

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



Fig. 9: Ethernet interface, pin numbering.

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 at 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”. These make a cable length of up to 50 meters possible.

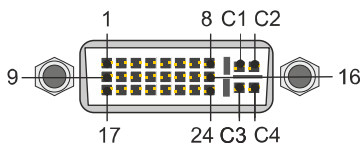


Fig. 10: DVI-I interface X200.

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

Pin	Assignment	Pin	Assignment	Pin	Assignment
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	Assignment
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 2560 x 1440 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

### 5.4.1 DVI-D (N010)

The DVI-D interface (X300) transfers digital data and is suitable for connection to digital displays. If the optional N010 interface (DVI-D interface) is used, the first DVI-I interface can be operated either in VGA mode or in DVI mode. The resolution at 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". These make a cable length of up to 50 meters possible.

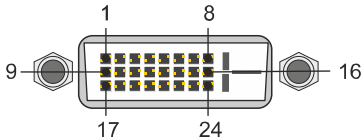


Fig. 11: DVI-D interface X300.

Table 11: DVI-D interface X300, pin assignment.

Pin	Assignment	Pin	Assignment	Pin	Assignment
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 12: DVI-D interface X300, 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 2560 x 1440 pixels can be set on the Embedded PC. Whether this resolution is achieved depends on the monitor, the cable quality and the cable length.

### 5.4.2 DisplayPort (N011)

The DisplayPort transfers image and audio signal at the same time and is therefore suitable for connecting panels or monitors to the Embedded PC.

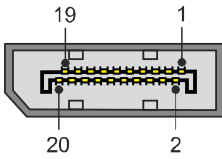


Fig. 12: DisplayPort X300.

Version 1.1a of the DisplayPort (DisplayPort++) is installed on the Embedded PC. Adapters from DisplayPort to DVI-D or DisplayPort to HDMI can be used to connect monitors without DisplayPort to the Embedded PC.

Table 13: DisplayPort, pin assignment.

Pin	Assignment	Pin	Assignment
1	LVDS lane 0+	2	Ground
3	LVDS lane 0-	4	LVDS lane 1+
5	Ground	6	LVDS lane 1-
7	LVDS lane 2+	8	Ground
9	LVDS lane 2-	10	LVDS lane 3+
11	Ground	12	LVDS lane 3-
13	Config 1	14	Config 2
15	AUX channel+	16	Ground
17	AUX channel-	18	Hot-plug detection
19	Power supply: ground	20	Power supply: 3.3 V / 500 mA

Table 14: DisplayPort X300, resolution at the monitor.

Interface	Resolution in pixels
DisplayPort	max. 2560 x 1600 @ 60 Hz
DisplayPort with adapter, DisplayPort to DVI-D	max. 1600 x 1200 @ 60 Hz

### 5.4.3 RS232 (N030)

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

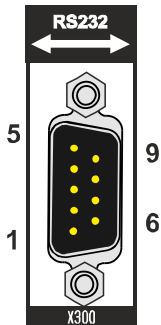


Fig. 13: RS232 interface X300 with pin numbering.

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 15: RS232 interface X300, pin assignment.

PIN	Signal	Type	Description
1	DCD	Signal in	Data Carrier Detected
2	RxD	Signal in	Receive Data
3	TxD	Signal out	Transmit Data
4	DTR	Signal out	Data Terminal Ready
5	GND	Ground	Ground
6	DSR	Signal in	Dataset Ready
7	RTS	Signal out	Request to Send
8	CTS	Signal in	Clear to Send
9	RI	Signal in	Ring Indicator



### 5.4.4 RS422/RS485 (N031)

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

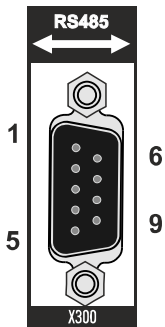


Fig. 14: RS485 interface X300 with pin numbering.

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 16: 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 RS485 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 17: 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.

### 5.4.5 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.

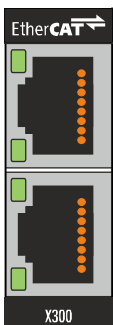


Fig. 15: EtherCAT slave interface X300.

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



Fig. 16: EtherCAT slave LAN interface, pin numbering.

Table 18: 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 optional EtherCAT slave interface (B110), documentation with further information is available for download from the Beckhoff website:

<https://www.beckhoff.de/german/download/epc.htm?id=71003127100362>

Document name
CXxxx0-B110 optional interface EtherCAT slave.

### 5.4.6 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.

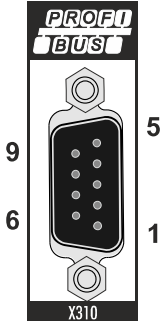


Fig. 17: PROFIBUS interface X310 with pin numbering.

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

Table 19: PROFIBUS interface X310, pin assignment.

Pin	Assignment
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 20: Wire colors of the PROFIBUS line.

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

For the optional PROFIBUS interface (x310), documentation with further information is available for download from the Beckhoff website:

<https://www.beckhoff.de/german/download/epc.htm?id=71003127100362>

Document name
CXxxx0-x310 optional Profibus interface.

### 5.4.7 CANopen (x510)

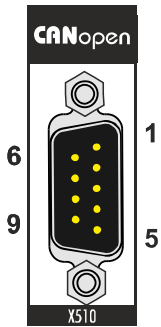


Fig. 18: CANopen interface X510 with pin numbering.

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

Table 21: CANopen interface X510, pin assignment.

Pin	Assignment
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 optional CANopen interface (x510), documentation with further information is available for download from the Beckhoff website:

<https://www.beckhoff.de/german/download/epc.htm?id=71003127100362>

Document name
CXxxx0-x510 optional CANopen interface.

### 5.4.8 PROFINET RT (x930)

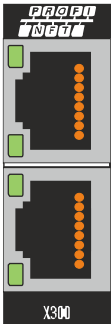


Fig. 19: PROFINET RT interface X300.



Fig. 20: PROFINET RT LAN interface, pin numbering.

Table 22: 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		

## 6 Commissioning

### 6.1 Selecting the appropriate CX2100 power supply unit

The basic CPU module requires a power supply unit of type CX2100-0014. Attach the AC adapter to the multi-pole connector of the basic CPU module on the right.

None of other power supply units of the CX2000 family are suitable for the CX20x2 Embedded PC.

Table 23: Suitable power supply unit for the CX20x2 Embedded PC.

Basic CPU module	Power supply unit
CX2042	CX2100-0014 (130 W)
CX2062	
CX2072	

#### Configuration of the power supply terminal

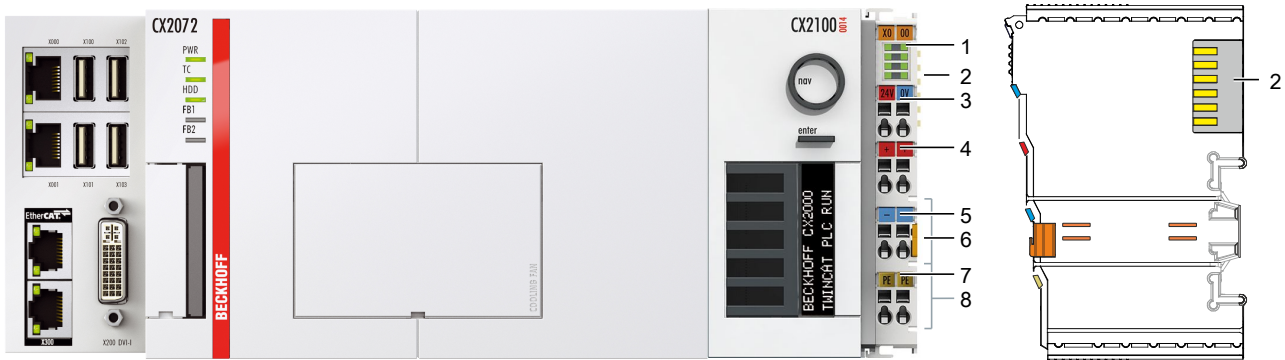


Fig. 21: Embedded PC CX2042 with power supply unit CX2100-0014, configuration of the power supply terminal.

Table 24: Legend for configuration of the power supply terminal.

No.	Description	No.	Description
1	Diagnostic LEDs	5	0 V, Bus Terminal supply
2	Terminal bus (K- or E-bus)	6	Terminal release
3	+24 V and 0 V, for basic CPU module	7	PE, spring-loaded terminal
4	+24 V, Bus Terminal supply	8	+24 V, 0 V, PE, for power contacts

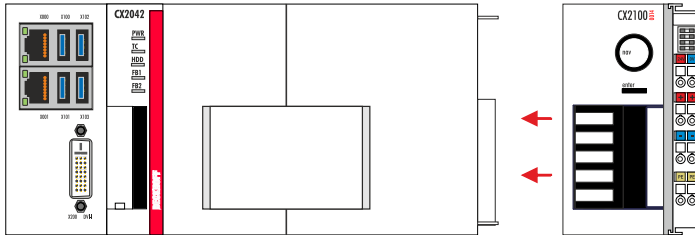
## 6.2 Mounting

### 6.2.1 Attaching the power supply unit

The basic CPU module requires the CX2100-0014 power supply unit. Connect the power supply unit via the multi-pole port on the right of the basic CPU module.

**Proceed as follows:**

1. Use the CX2100-0014 power supply unit.
2. Attach the power supply unit on the right of the basic CPU module.



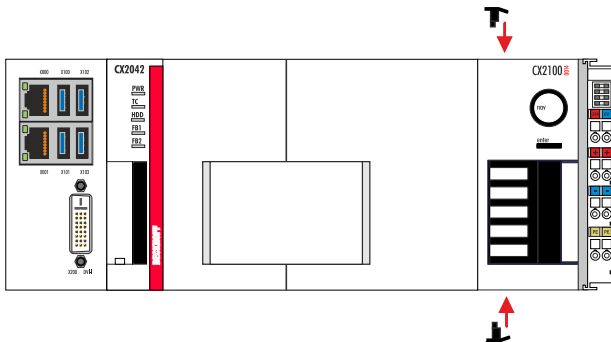
⇒ Next you can install the bar clips.

### 6.2.2 Installing the bar clips

Usually, the connection between the modules is strong enough. However, the basic CPU module and the attached modules may be subjected to shocks, vibrations or other impacts. The modules can be securely connected to one another with the aid of bar clips.

**Install the bar clips as follows:**

1. Attach the bar clips at the top and bottom between the cooling fins.



2. Push the bar clips between the cooling fins of your devices, as shown in the image below.



⇒ The bar clips have been installed successfully, if they don't protrude and are level with the cooling fins of your modules.

Once all modules are latched, the devices can be installed on the mounting rail.

### 6.2.3 Note the permissible installation positions



#### Note

#### Increased heat generation

The Embedded PC may overheat if the minimum distances are not adhered to.

The Embedded PC may only be operated at ambient temperatures of up to 50 °C. Ensure adequate ventilation. Leave at least 30 mm clearance above and below the Embedded PC.

Note the following specifications for the control cabinet:

- The Embedded PC should only be operated at ambient temperatures between -25 °C and 50 °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 PCs.
- Additional electrical equipment affects the heat generation in the control cabinet. Select a suitable control cabinet enclosure depending on the application, or ensure that excess heat is dissipated from the control cabinet.

The Embedded PCs can be mounted horizontally, vertically or horizontally on a mounting rail. Use only the CX2100-0014 power supply unit.

#### Horizontal installation position

The permissible ambient temperature range is -25 to 50 °C. In addition, a minimum clearance of 30 mm above and below the cooling fins of the Embedded PCs is required in order to ensure adequate ventilation. This ensures optimum air flow through the cooling fins of the Embedded PC.

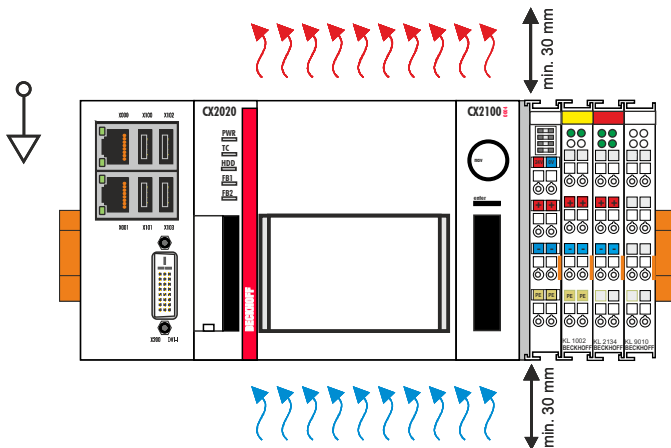


Fig. 22: Embedded PC CX20x2, horizontal installation position.

If there is a risk of vibrations or impact in the same direction as the mounting rail when the Embedded PC is installed horizontally, the device must be secured with an additional bracket in order to prevent it slipping.



**Vertical mounting position**

The minimum distance of at least 30 mm above and below the cooling fins of the Embedded PC must also be adhered to when the device is mounted vertically.

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

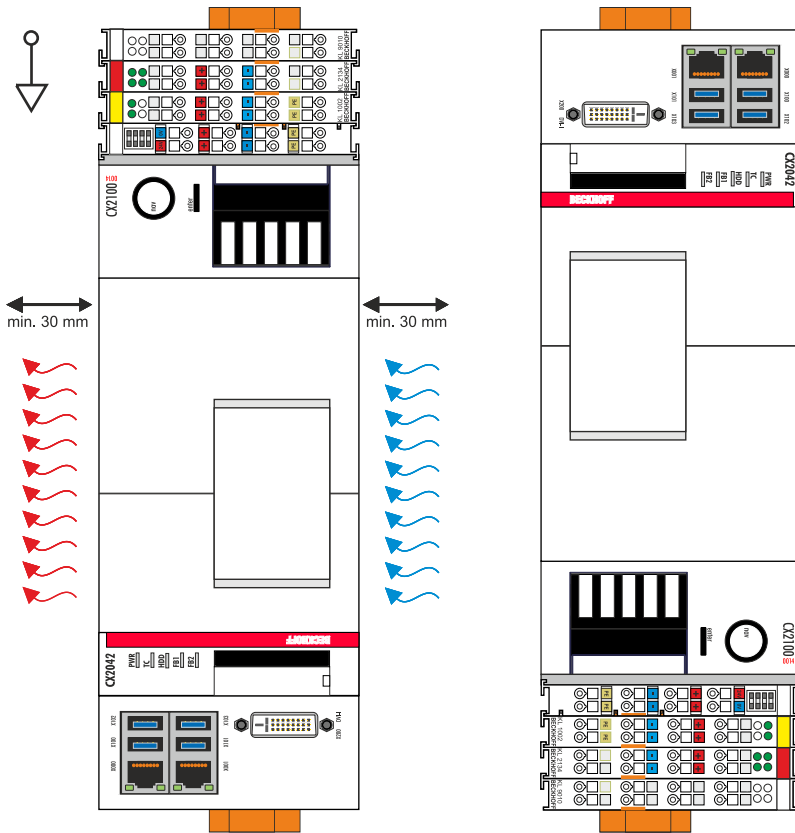


Fig. 23: CX20x2 Embedded PC, vertical mounting position.

If you install the Embedded PC vertically, the device must be fastened properly to prevent it slipping off the DIN rail. Install a bracket below the Embedded PC for this purpose.

**Horizontal mounting position**

The minimum distance of at least 30 mm above and below the cooling fins of the Embedded PC must also be adhered to when the device is mounted horizontally.

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

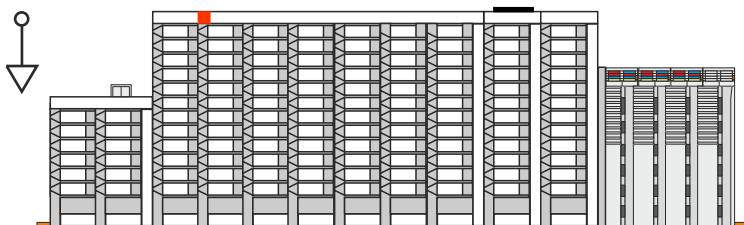


Fig. 24: CX20x2 Embedded PC, horizontal mounting position.

If there is a risk of vibrations or impact in the same direction as the mounting rail when the Embedded PC is installed horizontally, the device must be secured with an additional bracket in order to prevent it slipping.

## 6.2.4 Attaching on mounting rail

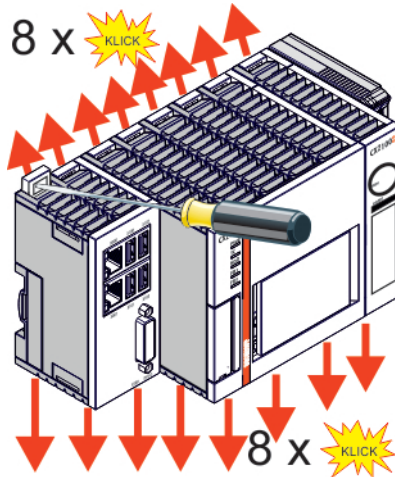
The housing is designed such that the Embedded PC can be pushed against the mounting rail and latched onto it.

Requirements:

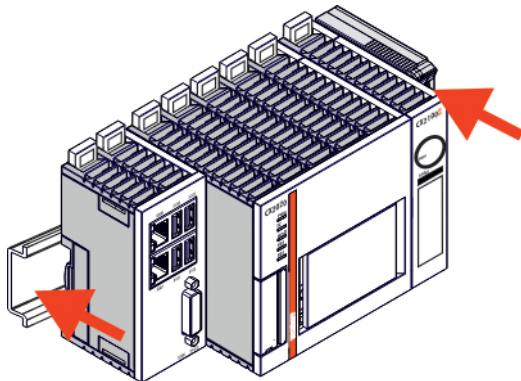
- Mounting rail of type TS35/7.5 or TS35/15 according to DIN EN 60715.

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

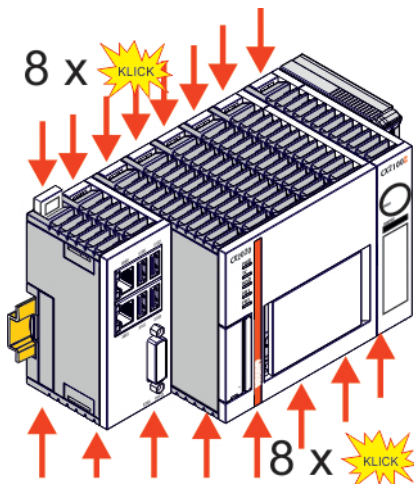
1. Unlock the latches at the top and bottom.



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



3. Then lock the latches again.



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

## 6.2.5 CFast card installation and removal



**Note**

**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).

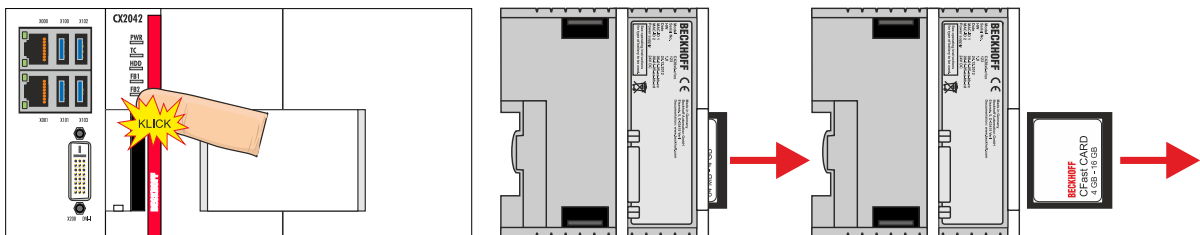
The eject mechanism is based on the push/push principle. The installation and removal of CFast cards is described below.

Requirements:

- The basic CPU module must be switched off. The CFast cards may only be installed or removed in switched off state.

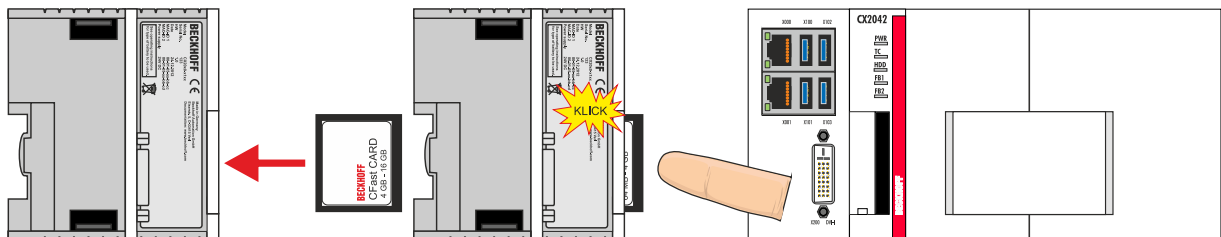
### Removing a CFast card

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. Pull out the card.



### Installing a CFast card

1. Push the CFast card into the CFast card slot.



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

⇒ The card is seated correctly if it is flush with the front side of the device housing.

## 6.2.6 Installing passive EtherCAT Terminals



**Note**

### Incorrectly installed passive EtherCAT Terminals

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. In the tree structure the EtherCAT Terminal is displayed without process image, and the value in column "E-bus (mA)" does not change, compared to the preceding EtherCAT Terminal.

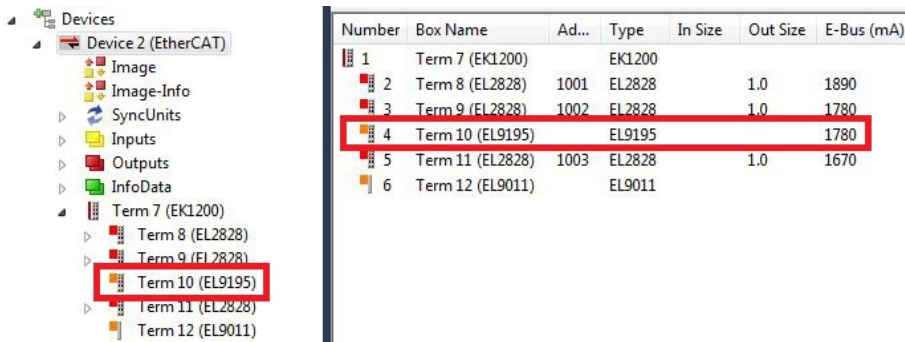


Fig. 25: Identifying a passive EtherCAT Terminal in TwinCAT.

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.

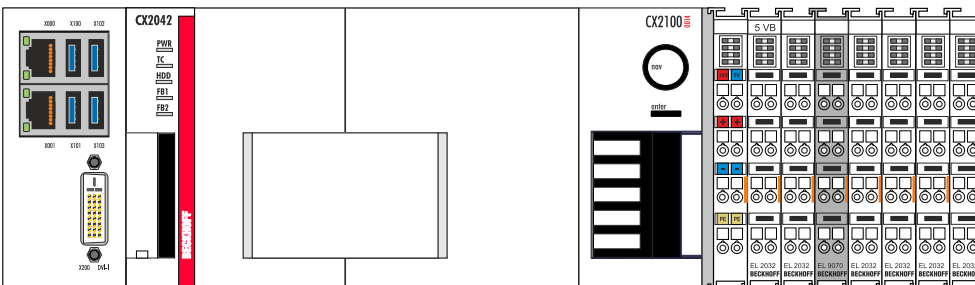


Fig. 26: Passive EtherCAT Terminals, permissible installation.

The following diagram shows the invalid installation of a passive EtherCAT Terminal.

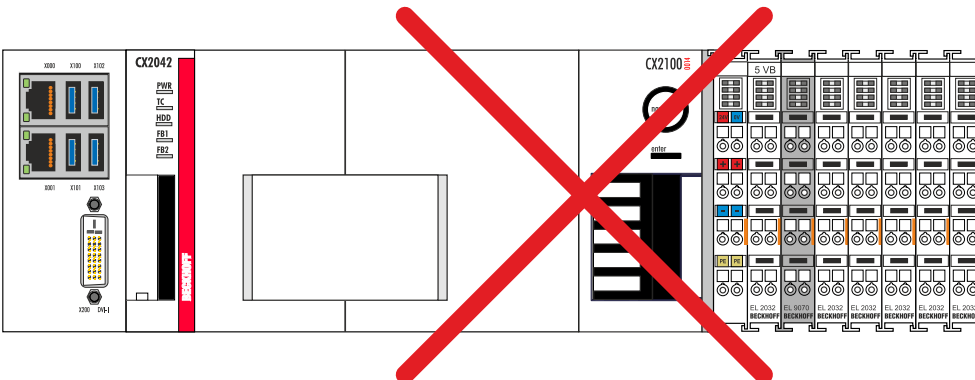


Fig. 27: Passive EtherCAT Terminals, invalid installation.

### 6.3 Connecting the power supply



Note

#### 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 CX2100-0014 power supply units require an external voltage source, which provides 24 V DC (-15% / +20%). The CX2100-0014 power supply unit has to supply 4 A at 24 V in order to ensure the operation of the basic CPU modules in all situations.

A 4 A fuse should be used for the power supply of the basic CPU module.

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

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

#### Connection example with CX2020 basic CPU module and CX2100-0014 power supply unit:

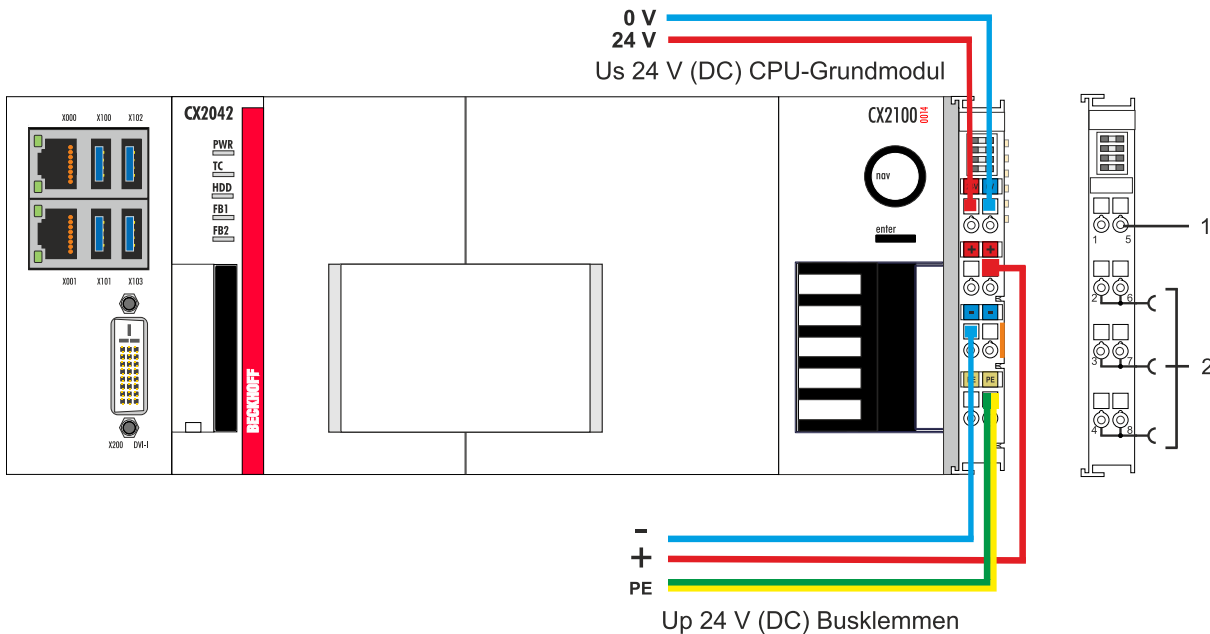


Table 25: Legend for the connection example

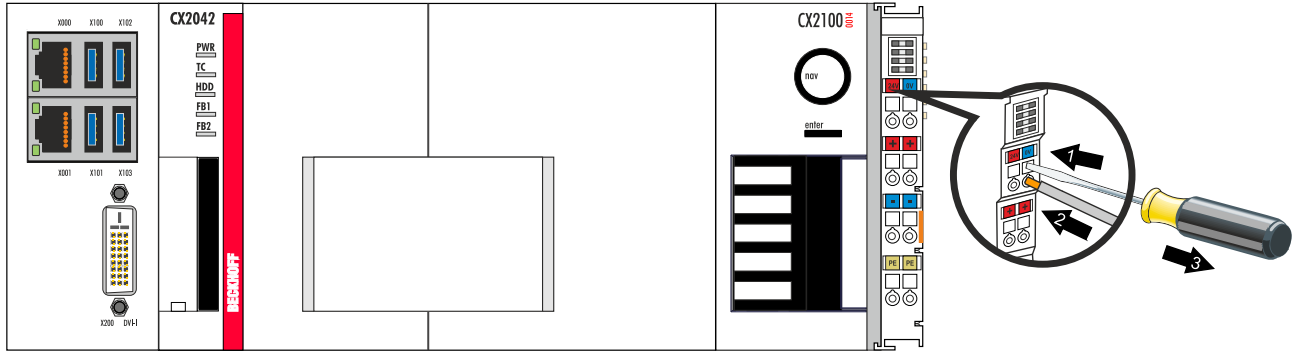
No.	Description
1	The upper spring-loaded terminals identified with "24 V" and "0 V" supply the basic CPU module and the terminal bus (data transfer via K- or E-bus).
2	The spring-loaded terminals identified as "+", "-", and "PE" supply the Bus Terminals via the power contacts and the sensors or actuators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

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

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

Table 26: Required wire cross-sections and strip lengths

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

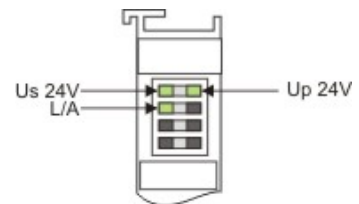


1. Open a spring-loaded terminal by slightly pushing with a screwdriver or a rod into the square opening above the terminal.
2. The wire can now be inserted into the round terminal opening without any force.
3. The terminal closes automatically when the pressure is released, holding the wire safely and permanently.

**Power supply unit LEDs**

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

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



**Note**

**Interrupting / switching off the power supply**

To switch off the Embedded PC, do not disconnect the ground (0 V), because otherwise current may continue to flow via the shielding, depending on the device, and damage the Embedded PC or peripheral devices. Always disconnect the 24 V line. Devices connected to the Embedded PC, which have their own power supply (e.g. a Panel) must have the same potential for "PE" and "0 V" as the Embedded PC have (no potential difference).

## 6.4 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 whether the Embedded PC is mounted securely on the DIN rail and all required Bus Terminals are connected.
  3. 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.

## 6.5 Switching off



### Note

#### 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.

### 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 Windows 10 IoT Enterprise LTSB

#### 7.1.1 Identification of the Ethernet interfaces (X000, X001)

##### Network and Sharing Center

In the Network and Sharing Center the Ethernet interfaces (X000, X001) of the CX20x0 Embedded PC are identified as follows as standard:

- Ethernet 2 corresponds to the Ethernet interface X000.
- Ethernet corresponds to the Ethernet interface X001.

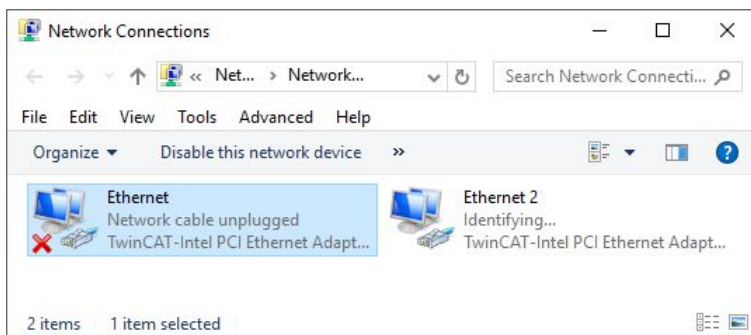


Fig. 28: Windows 10, Identification of the Ethernet interfaces (X000, X001) in the Network and Sharing Center.

##### Device Manager

In the Device Manager the Ethernet interfaces (X000, X001) of the CX20x0 Embedded PC are identified as follows as standard:

- TwinCAT Intel PCI Ethernet adapter (gigabit) corresponds to the Ethernet interface X001.
- TwinCAT Intel PCI Ethernet adapter (gigabit) #2 corresponds to the Ethernet interface X000.

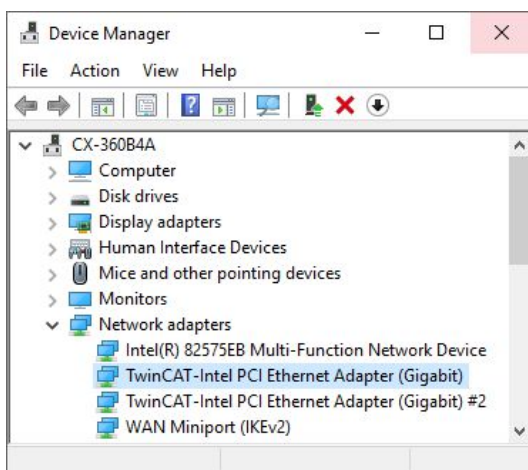


Fig. 29: Windows 10, identification of the Ethernet interfaces (X000, X001) in the device manager.



## 7.2 Beckhoff Device Manager

### 7.2.1 Starting the Beckhoff Device Manager

The Beckhoff Device Manager can be used to configure an Embedded PC with a web browser via a host PC. The Beckhoff Device Manager can also be used for diagnostic purposes.

Requirements:

- The host PC and the Embedded PC must be in the same network, and the network firewall must allow access via port 80.
- The IP address or the host name of the Embedded PC must be known.

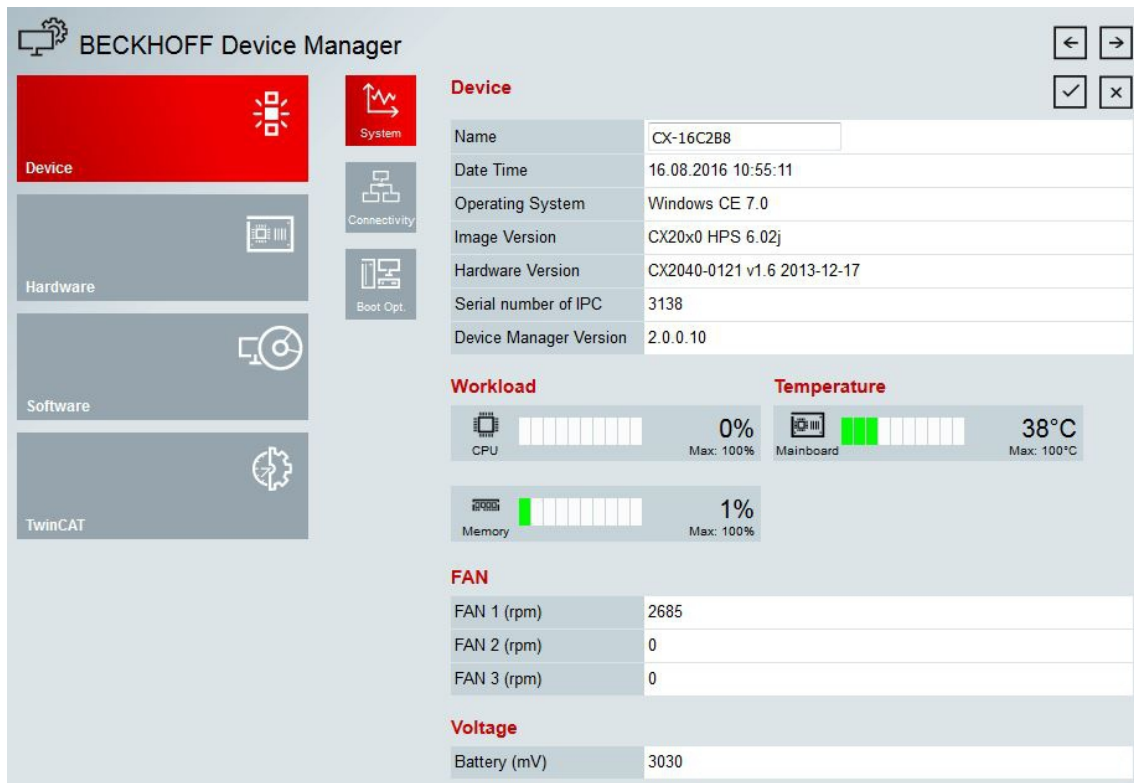
Access to the Beckhoff Device Manager is protected. The access data differ depending on the operating system.

Table 27: Access data for the Beckhoff Device Manager on delivery.

Operating system	Access data
Windows Embedded Standard 7 P, Windows 10 IoT Enterprise LTSB	User name: Administrator Password: 1
Windows Embedded Compact 7	User name: Webguest Password: 1

Start the Beckhoff Device Manager as follows:

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



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

## 7.3 TwinCAT

### 7.3.1 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 PCs must be added manually in TwinCAT 3.

The smallest possible configuration of a CX20x0 Embedded PC, consisting of a basic CPU module and a CX2100-0004 power supply unit, is displayed in the tree view of TwinCAT 3 as follows:

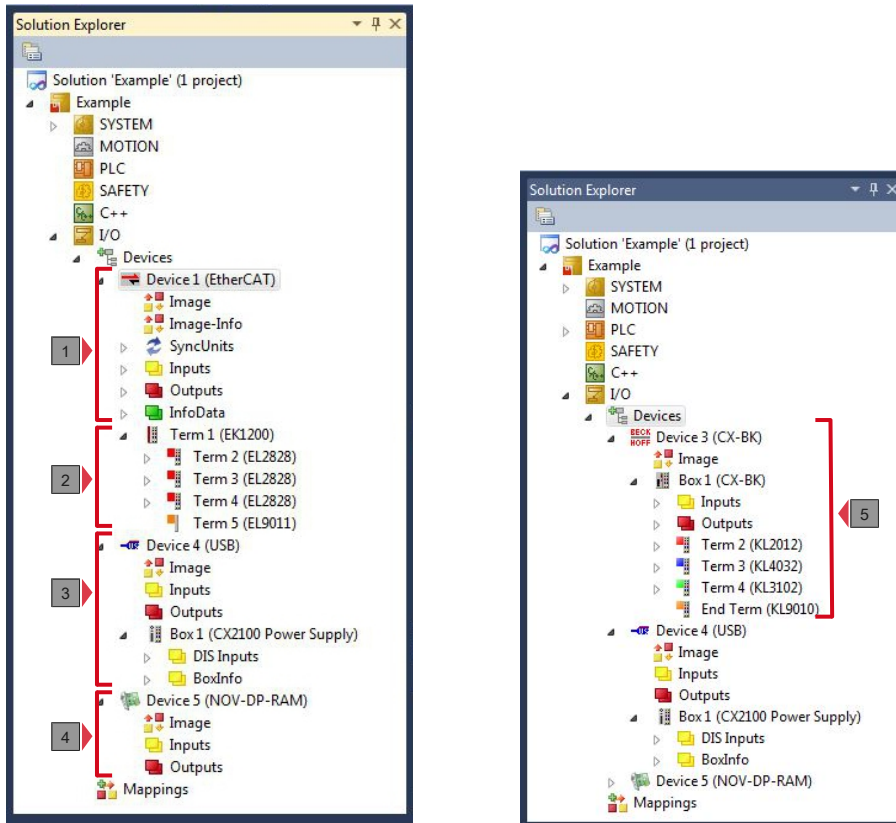


Fig. 30: CX20x0 Embedded PC in the tree view of TwinCAT 3, with attached EtherCAT Terminals (left) or Bus Terminals (right).

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

Table 28: Legend for the tree view.

No.	Description
1	The CX20x0 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	The power supply unit for the CX20x0 Embedded PC appears under a USB device. The power supply unit also has variables for diagnostic purposes.
4	The CX20x0 features NOVDRAM for storing up to 128 kB of data securely. At this point the NOVDRAM handler is created, followed by configuration of the retain variables.
5	If Bus Terminals (K-bus) are used together with a CX20x0 Embedded PC, the Bus Coupler (CX-BK) is added together with the Bus Terminals.

### 7.3.2 Adding an Embedded PC

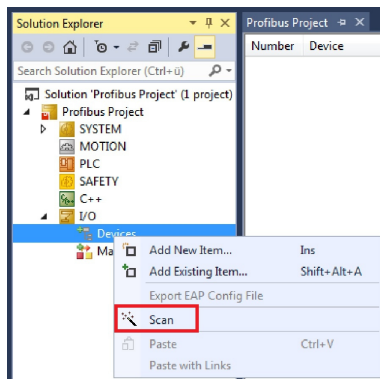
With this step you can add an Embedded PC in TwinCAT and then configure it.

Prerequisites for this step:

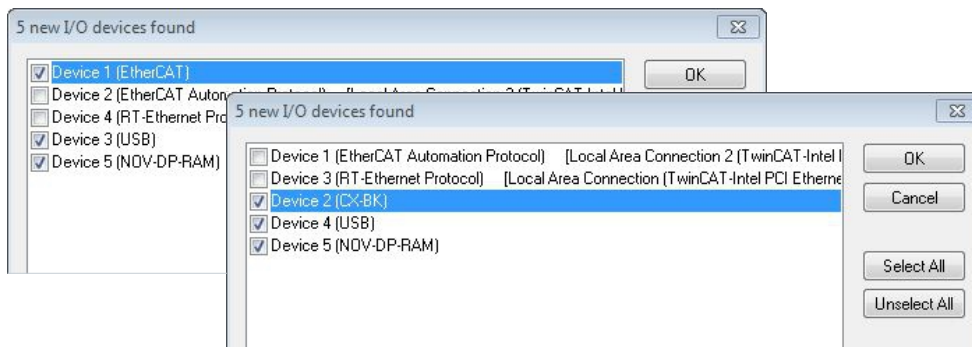
- A scanned and selected target device.

**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 added 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.

### 7.3.3 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 broken wires or unplugged LAN cables are avoided.

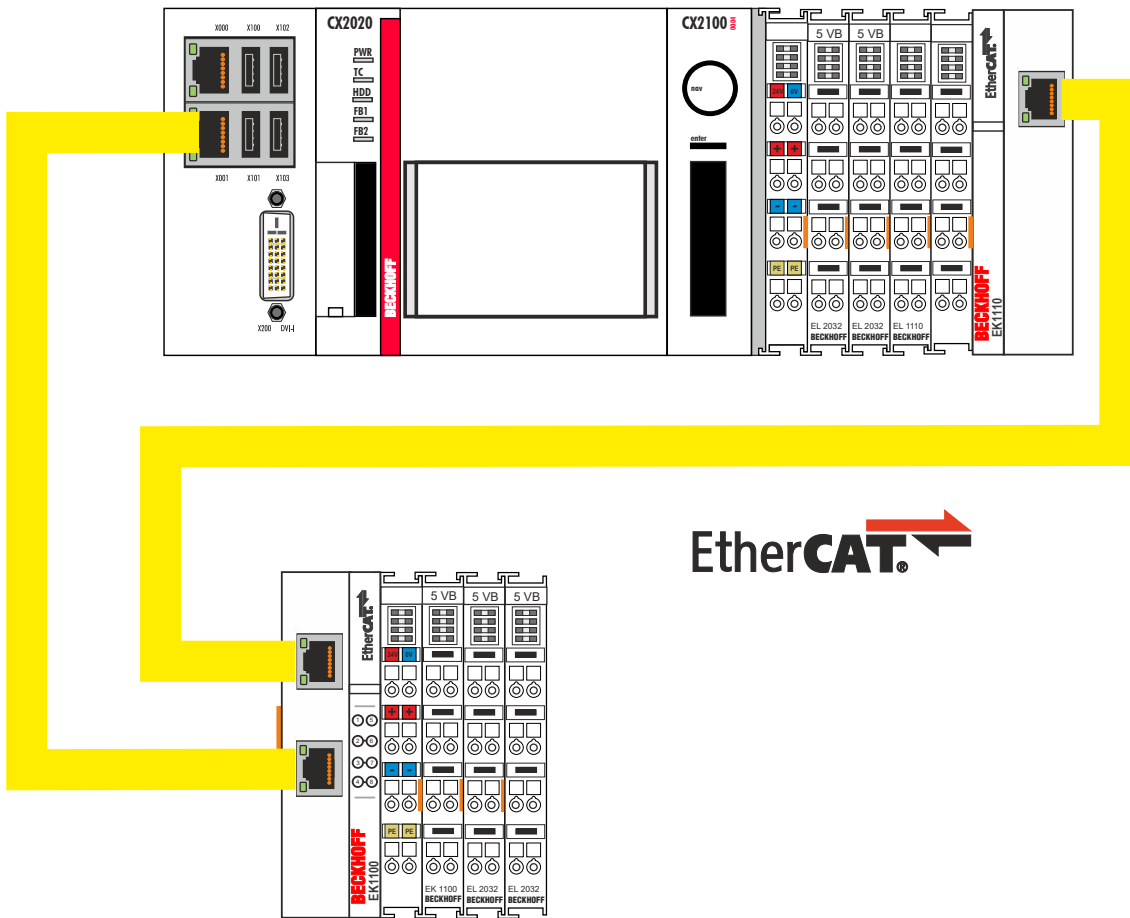


Fig. 31: Smallest possible configuration for EtherCAT cable redundancy.

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

Table 29: Cable redundancy, hardware for sample configuration.

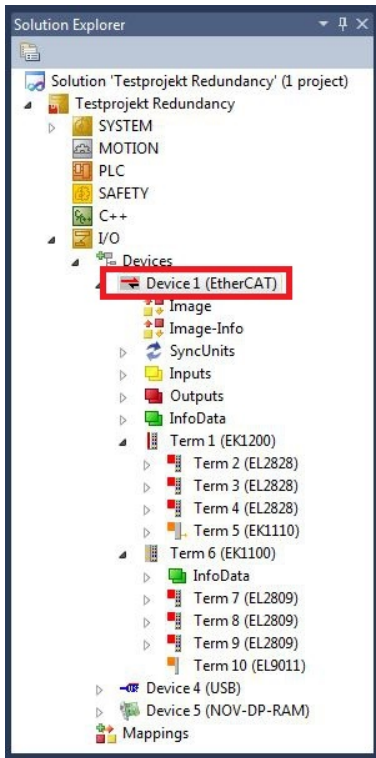
Type	Description
CX2020 Embedded PC	Is the EtherCAT master in the example.
Bus Coupler EK1110	EtherCAT extension can be used to extend an EtherCAT segment by up to 100 m.
EK1100 Bus Coupler	The Bus Coupler relays the EtherCAT signal to connected EtherCAT Terminals.
EtherCAT Terminals	Any number of EtherCAT Terminals can be connected to the CX20x0 Embedded PC and the Bus Coupler.

Requirements:

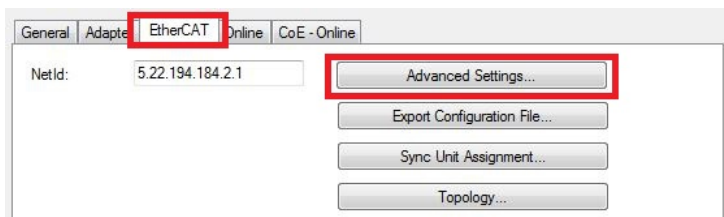
- For TwinCAT 2 you have to install and license the supplement TS622x | TwinCAT EtherCAT Redundancy on the Embedded PC:  
<http://www.beckhoff.de/forms/twincat3/warenkorb.aspx?lg=de&title=TS622x-EtherCAT-Redundancy&version=1.0.2>
- In TwinCAT 3 the supplement is already included and only has to be licensed.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

**Configure EtherCAT cable redundancy as follows:**

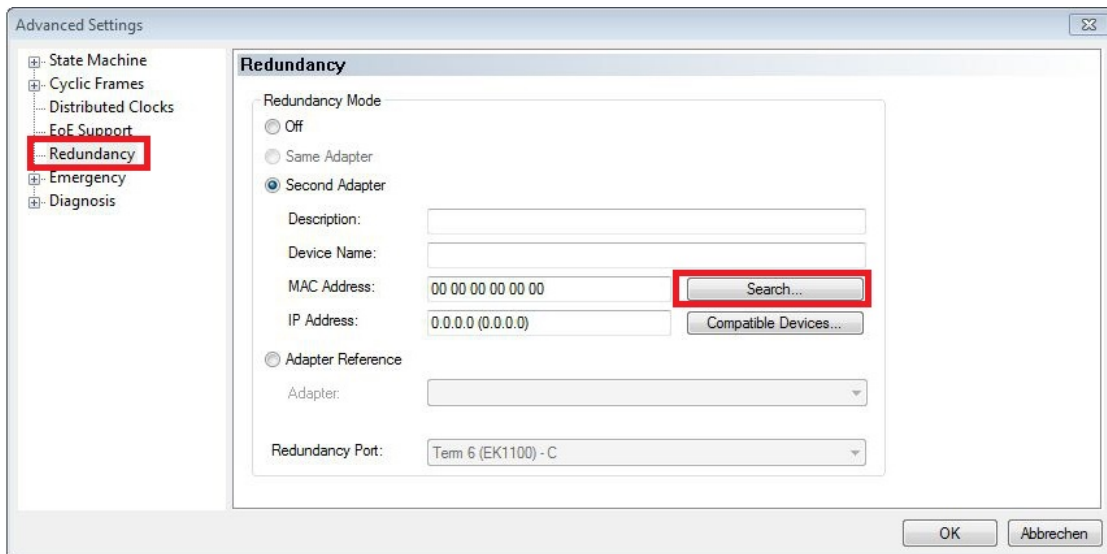
1. In the tree view click on the EtherCAT master.



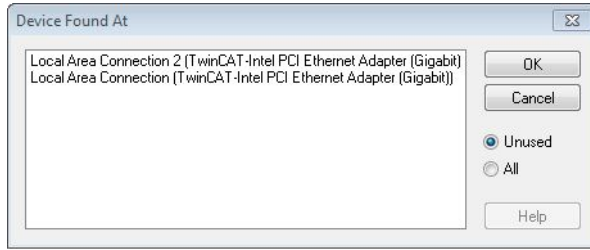
2. Click on the **EtherCAT** tab, then **Advanced Settings**.



3. Click on **Redundancy** in the tree structure on the left.
4. Click on the option **Second adapter**, followed by the **Search** button.



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



6. Confirm the settings with **OK**.

⇒ You have successfully configured cable redundancy. Under the **Online** tab the EtherCAT slaves are displayed, for which cable redundancy was configured.

Under **State** the state of the individual EtherCAT slaves is displayed. 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" appears under status.

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 show no fault.

If the cable connection is interrupted without cable redundancy at the same location, the terminals show a fault under status.

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

## 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.

This chapter illustrates how the NOVRAM is

- used in TwinCAT 3 (see: [Use under TwinCAT 3 \[▶ 48\]](#)).

### 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.

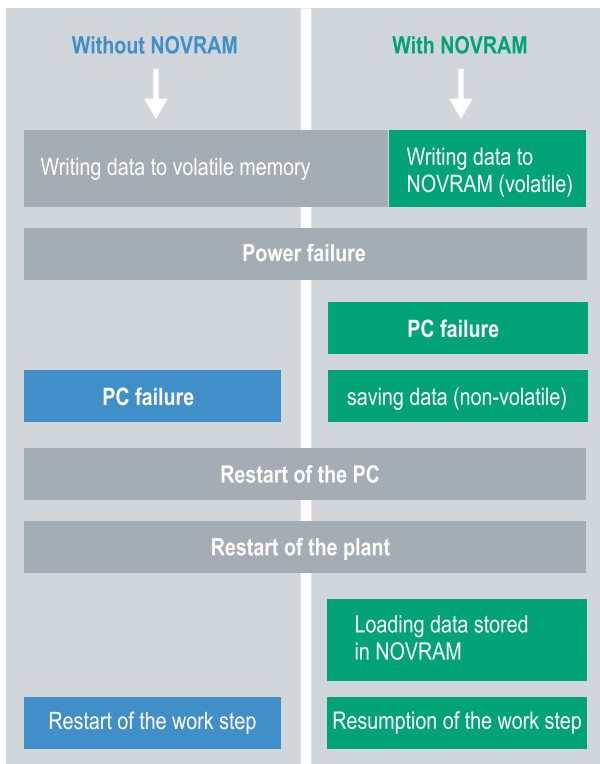


Fig. 32: Controller behavior with and without NOVRAM.

### 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)	CX9020, CX20x0, CX20x2	Tc2_IoFunctions

## 8.1 Use under TwinCAT 3

Under TwinCAT 3 (from Build 4020) a delta algorithm is used to save data in the NOVRAM. The algorithm does not save all the variables in the NOVRAM. Instead, it searches for changes (delta function) compared to the previous cycle and only saves variables that have changed.

To use the delta algorithm, a Retain Handler must be created in TwinCAT 3, and the relevant variables must be declared in the PLC with the keyword `VAR_RETAIN`.

A new feature of this method is that no function blocks have to be used. The Retain Handler saves data in the NOVRAM in the event of a power failure and makes them available again once the power has been restored.

### 8.1.1 Creating a Retain Handler

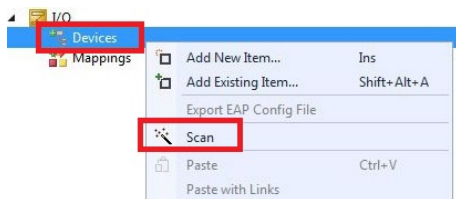
This chapter describes how to create a Retain Handler in TwinCAT 3. The Retain Handler saves data in the NOVRAM and makes them available again. In other words, important variable values such as production data or counter values are retained during a restart or power failure.

Prerequisites for this step:

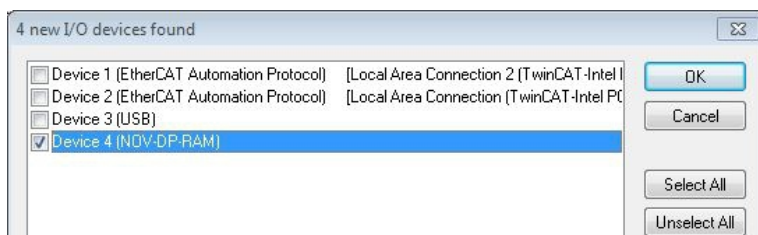
- TwinCAT 3.1 Build: 4020.
- A target device selected in TwinCAT.

**Create the Retain Handler as follows:**

1. Right-click on **Devices** in the tree view on the left-hand side.
2. In the context menu click on **Scan**.



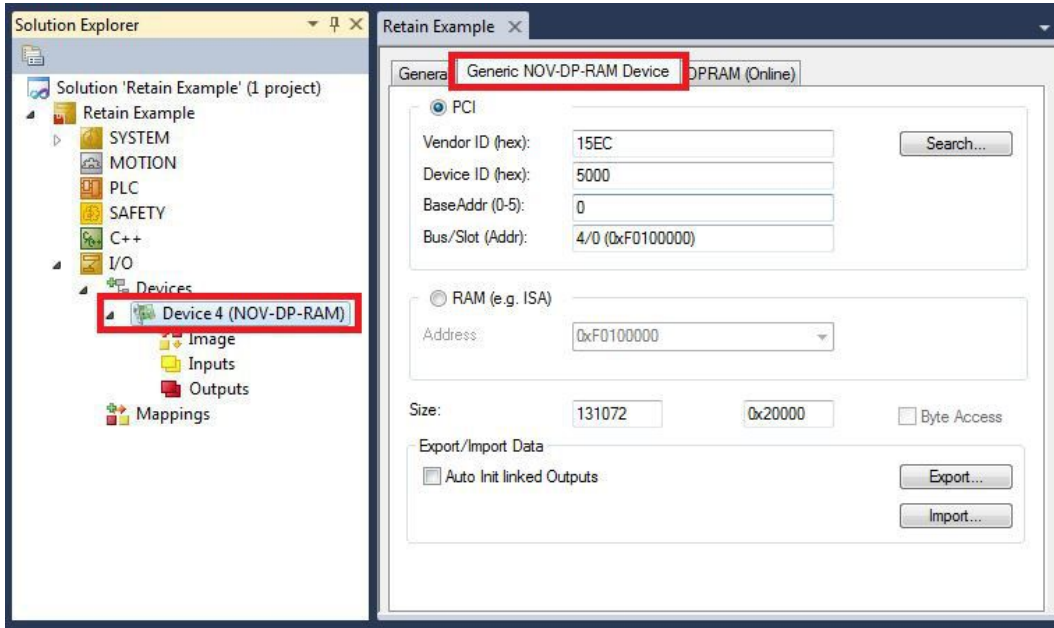
3. Select **Device (NOV-DP-RAM)** and confirm with **OK**.



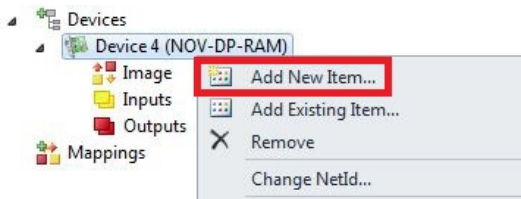
4. Click on **Yes** to search for boxes.



- Click on **Device (NOV-DP-RAM)** in the tree view on the left-hand side and then on the tab **Generic NOV-DP-RAM Device**.



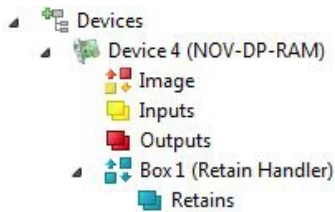
- Click on the option **PCI**.
- Right-click on **Device (NOV-DP-RAM)** in the tree view and then on **Add New Item**.



- Select the **Retain Handler** and click on **OK**.



⇒ You have successfully created a Retain Handler in TwinCAT.



In the next step you can create retain variables in the PLC and link them with the Retain Handler.

## 8.1.2 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:**

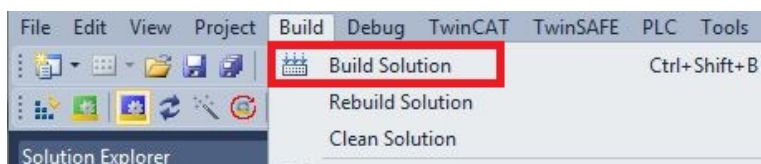
1. Create the variables in your PLC project in a VAR\_RETAIN area.

```

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**.

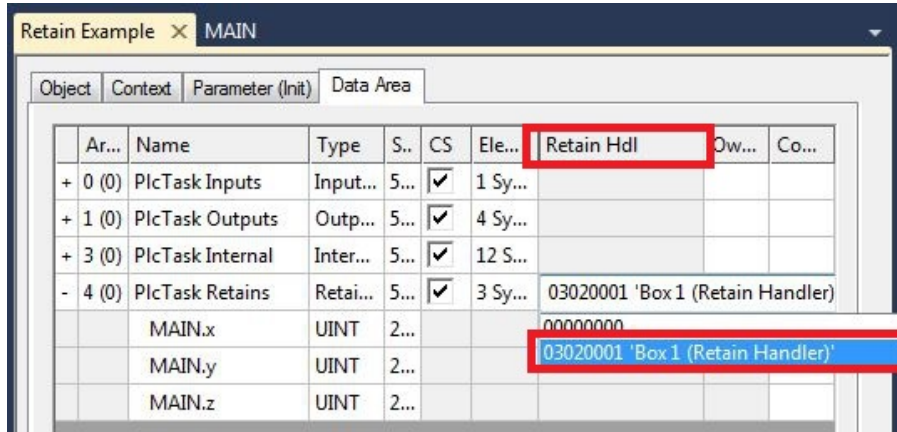


3. Click on **PLC Instance** in the tree view on the left and then on the tab **Data Area**.

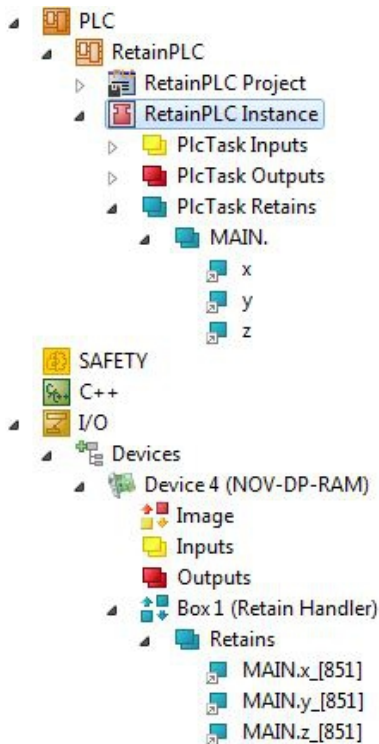
The image shows the TwinCAT software interface. On the left, the 'Solution Explorer' shows the project structure with 'RetainPLC Instance' selected and highlighted with a red box. On the right, the 'Data Area' tab is active, showing a table of variables. The 'Data Area' tab is also highlighted with a red box.

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.

### 8.1.3 Note the write 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.

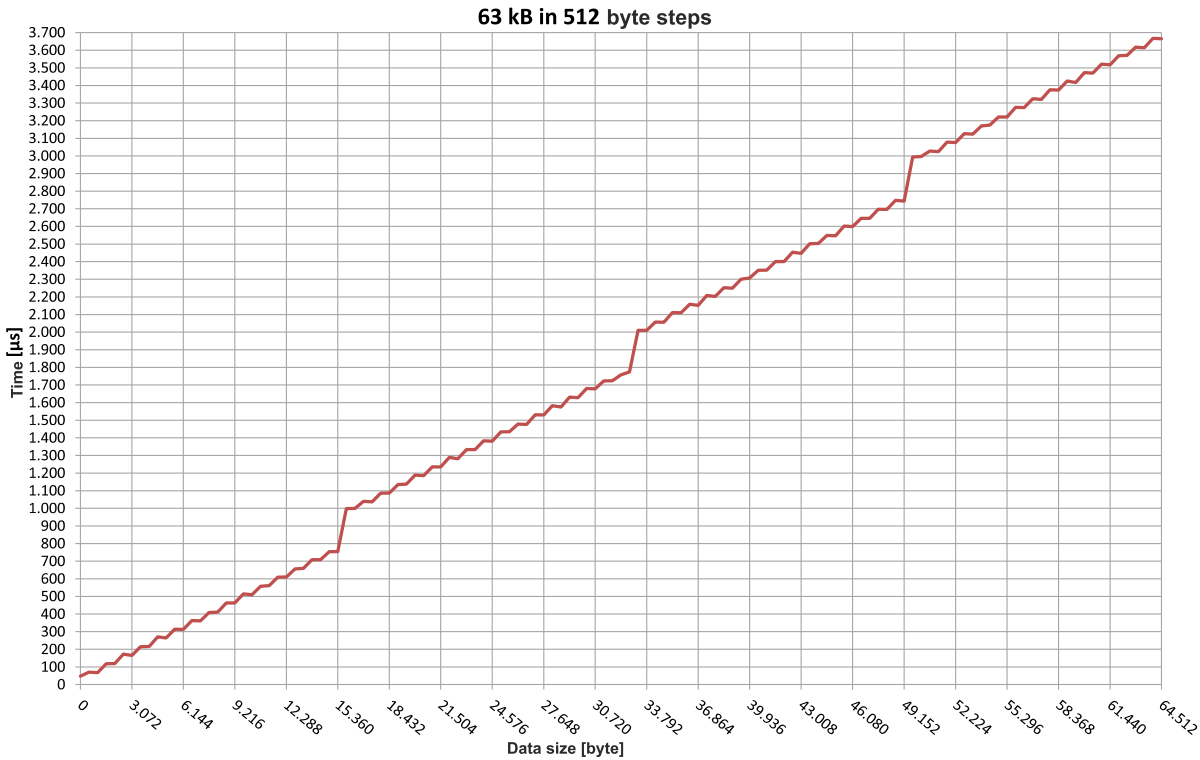


Fig. 33: Retain Handler write speed, up to 63 kB in 512 byte steps.

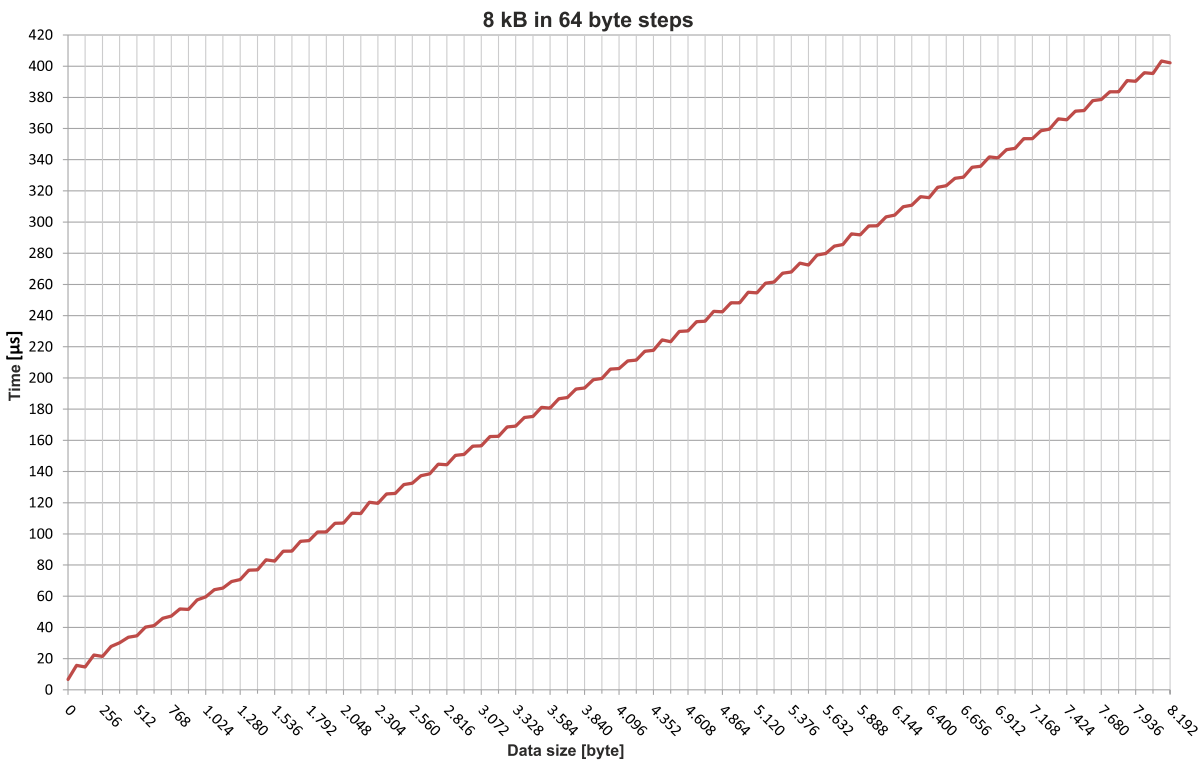


Fig. 34: Retain Handler write speed, up to 8 kB in 64 byte steps.

### 8.1.4 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.

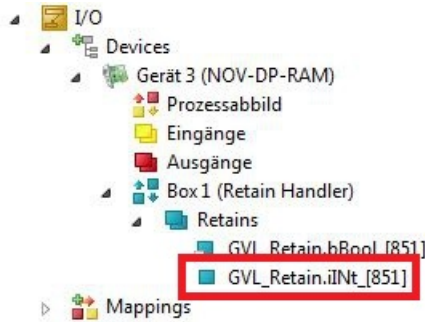
Under TwinCAT 3 the variables have to be deleted manually.

Prerequisites for this step:

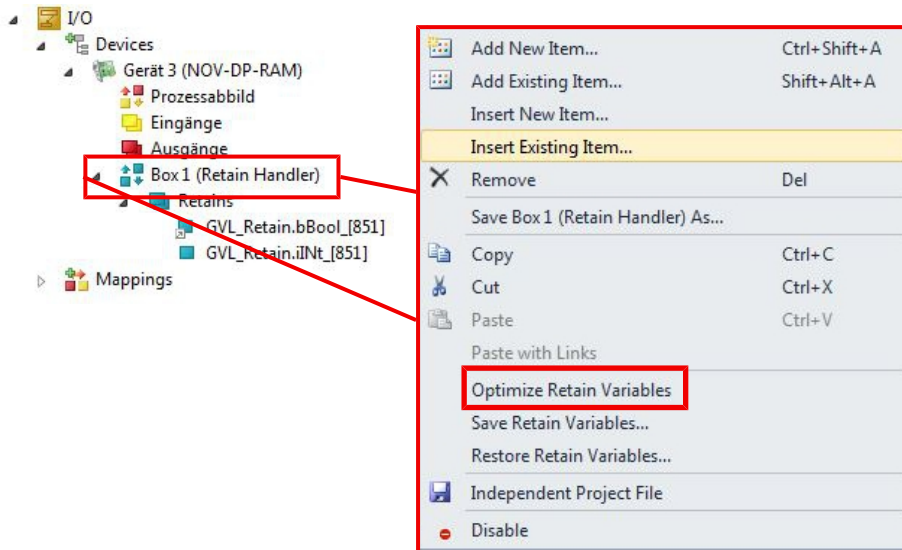
- Variables declared with VAR\_RETAIN were deleted from the PLC.

Delete the variables under the Retain Handler as follows:

1. The variable GVL\_Retain.iNt 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**.

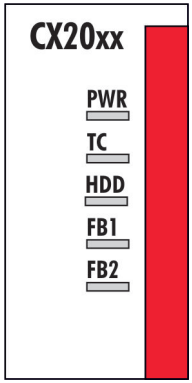


⇒ The variable under the Retain Handler is deleted.

## 9 Error handling and diagnostics

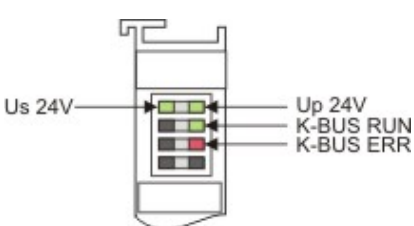
### 9.1 Basic CPU module

#### 9.1.1 LEDs on the basic CPU module

Display	LED	Meaning
	PWR	Power supply. The Power LED comes on when the device is connected to a live power supply unit (green).
	TC	TwinCAT status LED: TwinCAT is in Run mode (green). TwinCAT is in Stop mode (red). TwinCAT is in Config mode (blue).
	HDD	Read/Write CFast card (red). Indicates access to the CFast card.
	FB1	Status LED for optional interface (the function is described in the documentation for the respective optional interface).
	FB2	Status LED for optional interface (the function is described in the documentation for the respective optional interface).

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

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

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

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

Table 30: 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 31: 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.

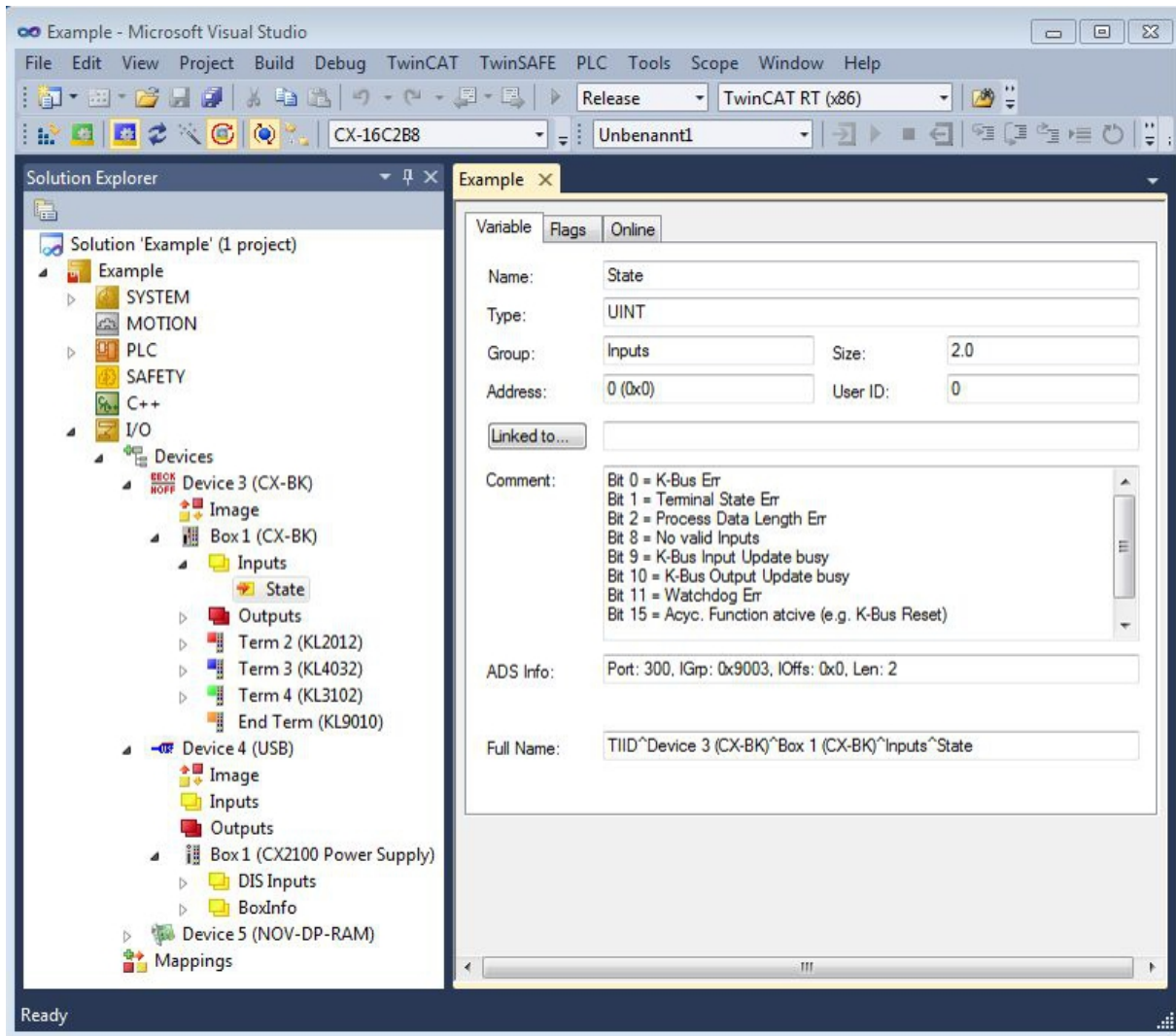


Fig. 35: Status variable for error handling and diagnostics under TwinCAT.

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 32: Description of the State variable values.

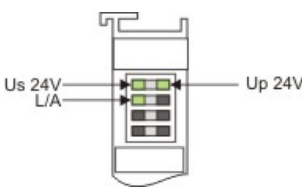
Bit	Description
Bit 0	K-bus error.
Bit 1	Terminal configuration has changed since the start.
Bit 2	Process image lengths do not match.
Bit 8	(still) no valid inputs.
Bit 9	K-bus input update not yet complete.
Bit 10	K-bus output update not yet complete.
Bit 11	Watchdog.
Bit 15	Acyclic K-bus function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

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



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

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

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

## 9.2 Faults

Table 33: Possible faults and their correction.

Fault	Cause	Measures
No function after the Embedded PC has been switched on.	<ul style="list-style-type: none"> <li>No power supply for the Embedded PC</li> <li>Other causes.</li> </ul>	<ol style="list-style-type: none"> <li>Check the fuse.</li> <li>Check the supply voltage and the connection.</li> <li>Call Beckhoff Support.</li> </ol>
Embedded PC does not boot fully.	Hard disk damaged (e.g. due to switching off while software is running), incorrect setup, other causes.	<ol style="list-style-type: none"> <li>Check the setup settings.</li> <li>Call Beckhoff Support.</li> </ol>
Computer boots, software starts, but control system 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 during CFast card access.	Faulty CFast card, faulty card slot.	<ol style="list-style-type: none"> <li>Use another CFast card to test the card slot.</li> <li>Call Beckhoff Support.</li> </ol>
Embedded PC only works partially or temporarily.	Defective components in the Embedded PC.	Call Beckhoff support.
The time and date are no longer saved.	The service life of the battery is exceeded	<a href="#">Replace the battery [► 59]</a> .
Fan is not turning.	Fan faulty.	Replace the fan cartridge.


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

1. Precise device ID: CXxxxx-xxxx.
2. Serial number.
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. Please consult our website at [www.beckhoff.de](http://www.beckhoff.de) or ask your distribution partner.

# 10 Care and maintenance

## 10.1 Replace the battery

 <b>Attention</b>	<p><b>Risk of explosion</b></p> <p>An incorrectly inserted battery may explode and damage the Embedded PC.</p> <p>Only use original batteries and ensure that the positive and negative poles are inserted correctly.</p>
---	---

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

Table 34: Technical data of the battery.

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

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

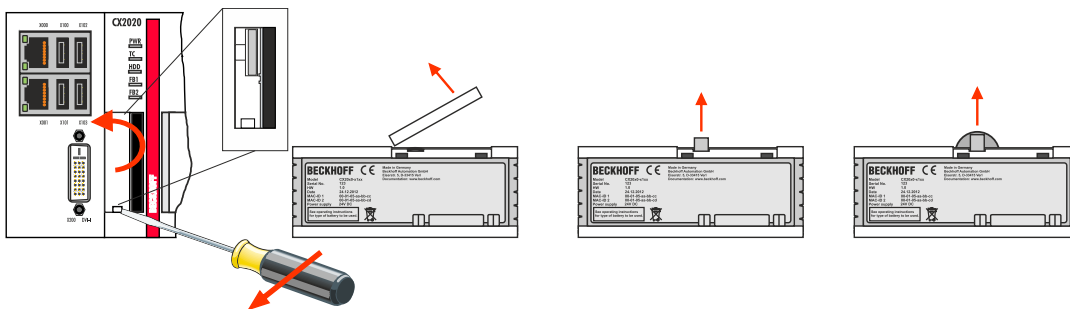
Be aware of this behavior for your hardware and software configuration and reset the time and date in the BIOS after a battery change. All other BIOS settings remain unchanged and are retained.

Requirements:

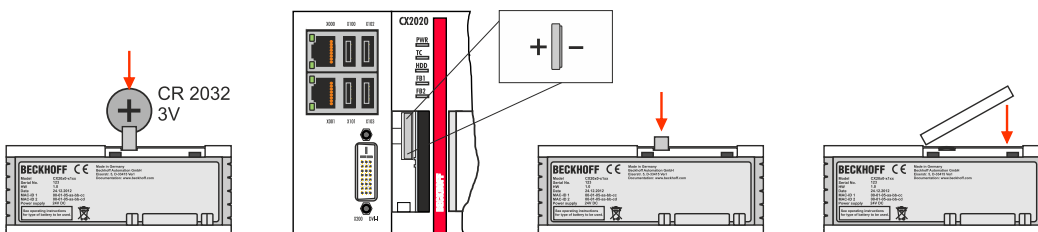
- The Embedded PC is switched off.

**Replace the battery as follows:**

1. Lever the front flap open with a screwdriver and remove it.
2. Carefully pull the battery from the bracket.



3. Push the new battery into the battery compartment. The positive 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.

## 10.2 Replace the fan cartridge



### Note

#### Service life

The fan cartridge must be replaced every 5 years. Spare fan cartridges can be ordered from Beckhoff Service.

Replace the fan cartridge of the CX20x2 if:

- the fan cartridge has been used for 5 years
- or the fan speed is less than 1000 rpm.

In a CX20x2 Embedded PC the fan speed is controlled depending on the temperature.

*Table 35: In the CX20x2 the fan control and speed depend on the temperature.*

Temperature	Fan control	Fan speed
up to 30 °C	30 %	3400 rpm
30 °C ... 75 °C	30 % ... 100 %, linear control	3400 rpm ... 6000 rpm, linear regulated
above 75 °C	100 %	6000 rpm

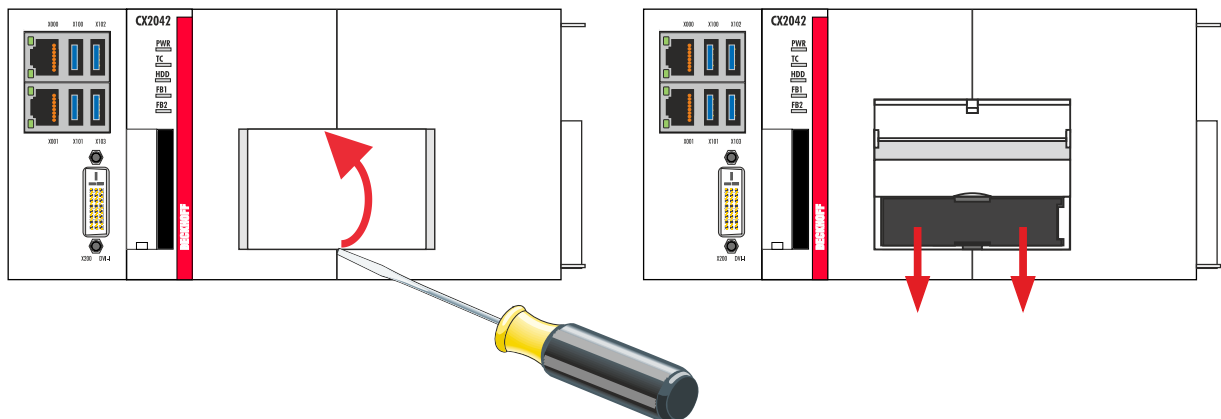
Use the IPC diagnostics and monitor the fan speed to determine a fan fault.

Access to the fan status is described in the documentation for the IPC diagnostics:

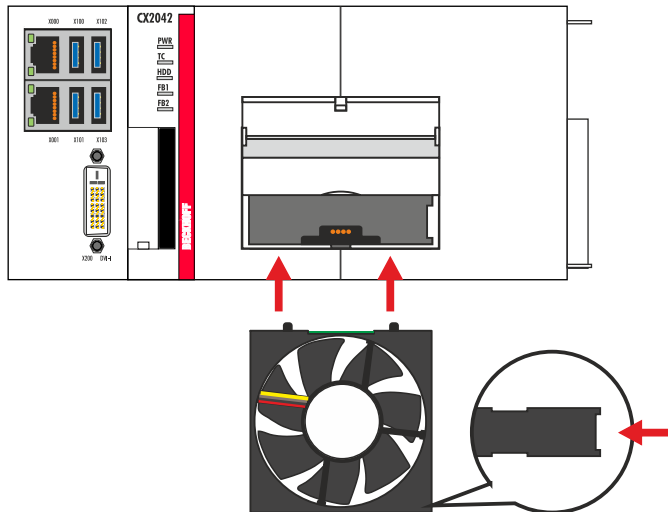
[https://download.beckhoff.com/download/document/ipc/industrial-pc/ipc\\_diagnose\\_de.pdf](https://download.beckhoff.com/download/document/ipc/industrial-pc/ipc_diagnose_de.pdf)

#### Replace the fan cartridge as follows:

1. Open the front flap.
2. Pull the old fan cartridge from the housing.



3. Push the new fan cartridge into the housing, with the contacts first. The guide rails at the fan match the guide rails in the housing.



⇒ Close the front flap. You have successfully changed the fan cartridge if the fan starts up again.

# 11 Decommissioning

## 11.1 Removing cables



### Note

#### Electrical voltage

Having the power supply switched on during the disassembly may damage the device. Switch off the power supply during the disassembly.



### Note

#### Cabling

Make a note of the wiring configuration, if you wish to restore it with another device.

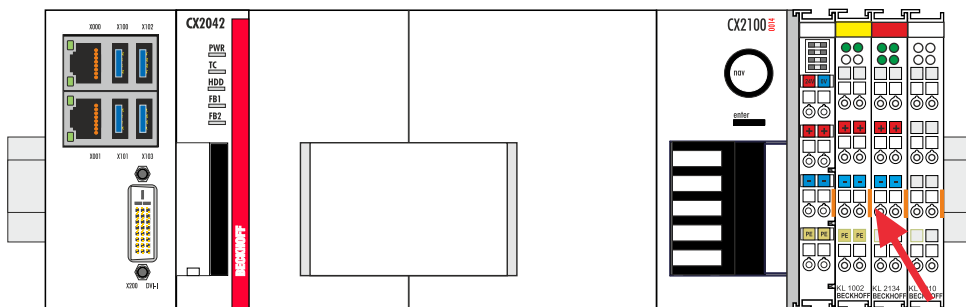
Before dismantling the Embedded PC, shut down the Embedded PC and switch off the power supply. Only then can you remove all the cables. Also remove all cables from the first terminal after the power supply terminal.

Requirements:

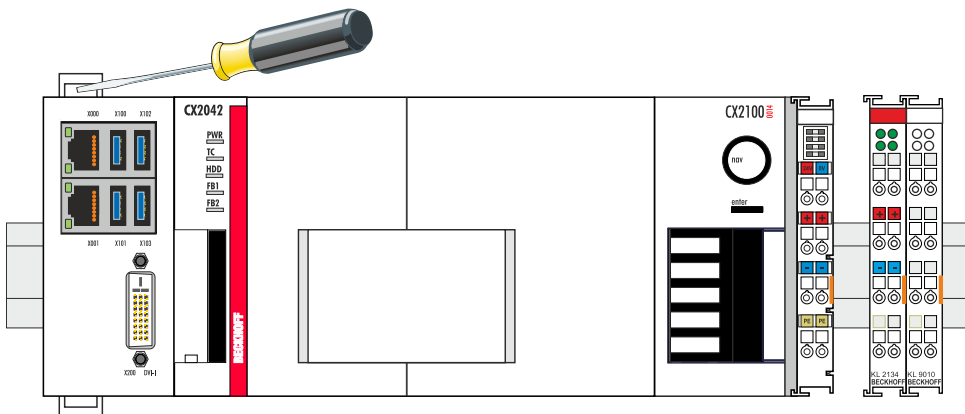
- Exit the software and shut down the Embedded PC.
- Switch off the power supply.

**Remove the cables as follows:**

1. Remove the wiring from the basic CPU module, any system interfaces that may be connected and the extension modules.
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.



## 11.2 Dismantling the Embedded PC

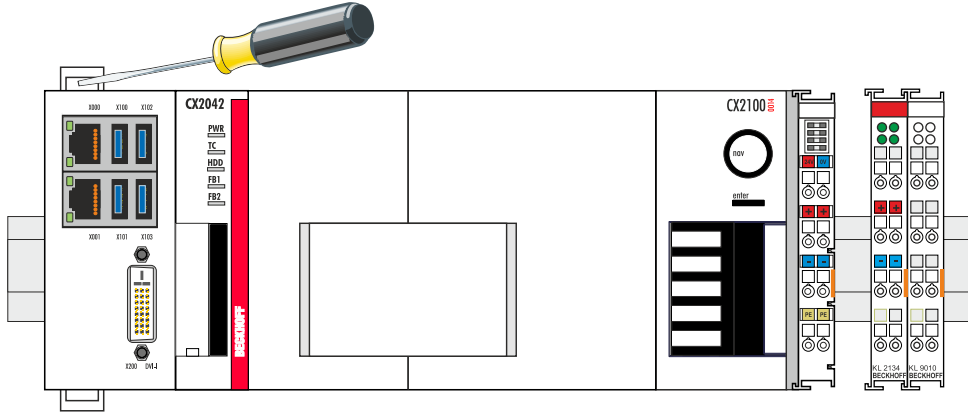
The CX2000 Embedded PC series is a modular system and enables individual modules to be replaced or removed quite easily. This section describes how to remove devices from the CX2000 Embedded PC series.

Requirements:

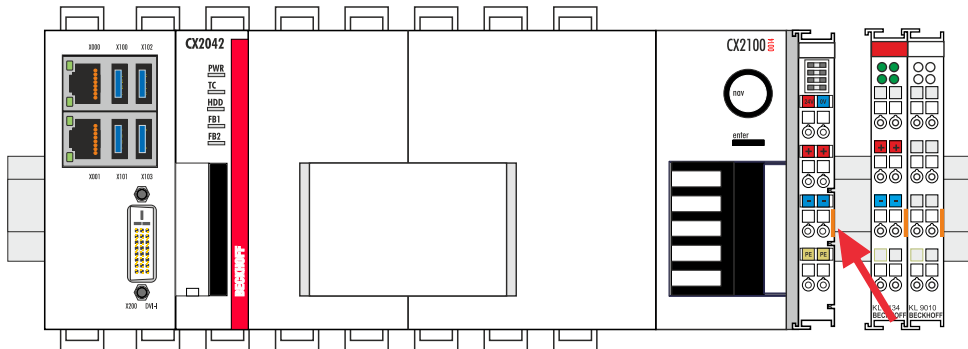
- All cables were removed from the Embedded PC.

**Dismantle the Embedded PC as follows:**

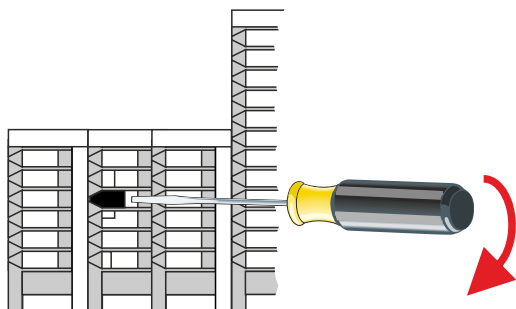
1. Release the DIN rail mounting by pushing the latches outwards with a screwdriver.

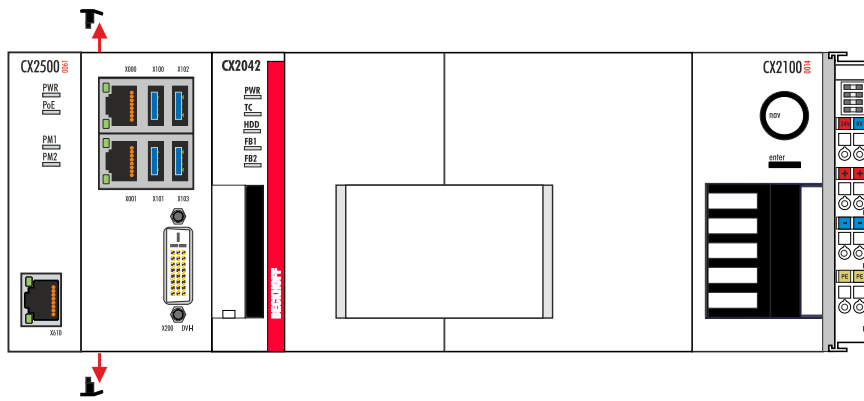


2. Pull the orange strap on the power supply unit and gently remove the device from the DIN rail.



3. Lift the bar clips with the aid of a screwdriver and remove the bar clips.





⇒ Once the bar clips have been removed successfully, the modules can be separated from each other.

### 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.



## 12 Technical data

Table 36: Technical data, dimensions and weights.

	CX2042	CX2062	CX2072
Dimensions (W x H x D)	204 mm x 99 mm x 91 mm		
Weight	approx. 1300 g		

Table 37: Technical data, general data.

Technical data	CX2042	CX2062	CX2072
Processor	Intel® Xeon® D-1527 2.2 GHz, 4 cores	Intel® Xeon® D-1548 2.0 GHz, 8 cores	Intel® Xeon® D-1567 2.1 GHz, 12 cores
RAM	8 GB DDR4 RAM (optionally expandable)		
Flash memory	Plug-in for CFast card, card not included		
NOVRAM integrated	128 kB		
Power supply	24 V DC (-15 %/+20 %)		
max. power loss	100 W (including the system interfaces)	110 W (including the system interfaces)	130 W (including the system interfaces)
Dielectric strength	500 V (supply / internal electronics)		
Operating system	Microsoft Windows 10 IoT Enterprise LTSC		
Control software	TwinCAT 3		
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		

Table 38: Technical data, I/O terminals.

Technical data	Description
I/O connection	via power supply unit (E-bus or K-bus, automatic detection)
Power supply for I/O terminals	max. 2 A
Power contacts current loading	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 39: Technical data, environmental conditions.

Technical data	Description
Ambient temperature during operation	-25° C ... +50° C
Ambient temperature during storage	-40 °C ... +85 °C see notes under: Transport and storage
Relative humidity	95 % no condensation
dynamic strength	according to EN 60068-2-6
Shock resistance	according to EN 60068-2-27
EMC immunity	according to EN 61000-6-2
Electromagnetic emission	according to EN 61000-6-4
Protection class	IP 20

Table 40: Technical data, graphic specifications.

Technical data	Description
Graphic system	AMD E8860
Graphic memory	2 GB GDDR5
Graphics clock frequency	625 MHz
Shader model	5.0
DirectX	12
OpenGL	4.5

Table 41: Technical data, interfaces.

Technical data	Description
LAN	2 x RJ 45, 10/100/1000 Mbit/s
USB	4 x USB 3.0 each rated at 900 mA, type A
DVI-I	Resolution on the monitor in pixels: 640 x 480 to 1920 x 1200

Table 42: Technical data, optional interfaces.

Technical data	Description
DVI-D	Resolution on the monitor in pixels: 640 x 480 to 1920 x 1200
DisplayPort	Resolution on the monitor in pixels: max. 2560x1600
RS232	D-Sub plug, 9-pole Electrical isolation 500 V
RS422/RS485	D-Sub plug, 9-pole Electrical isolation 500 V
EtherCAT slave	2 x RJ 45, EtherCAT IN and OUT 100 Mbaud
PROFIBUS	D-Sub plug, 9-pole 9.6 kbaud to 12 Mbaud
CANopen	D-Sub plug, 9-pole 10 kbaud to 1,000 kbaud
PROFINET RT	2 x RJ-45 switches

# 13 Appendix

## 13.1 Accessories

Table 43: CFast cards

Order number	Description
CX2900-0028	4 GB CFast card, SLC flash, extended temperature range
CX2900-0030	8 GB CFast card, SLC flash, extended temperature range
CX2900-0032	16 GB CFast card, SLC flash, extended temperature range
CX2900-0034	32 GB CFast card, SLC flash, extended temperature range
CX2900-0036	64 GB CFast card, SLC flash, extended temperature range
CX2900-0038	30 GB CFast card, 3D flash, extended temperature range
CX2900-0040	60 GB CFast card, 3D flash, extended temperature range

larger capacities on request

Table 44: HDD/SSD

Order number	Description
CX2900-0401	Hard disk, SATA, 2½-inch, 1 TB
CX2900-0502	Solid-state disk SSD, SATA, 3D flash, 2½-inch, 120 GB
CX2900-0503	Solid-state disk SSD, SATA, 3D flash, 2½-inch, 240 GB
CX2900-0504	Solid-state disk SSD, SATA, 3D flash, 2½-inch, 480 GB

larger capacities on request

Table 45: Passive DVI-to-VGA adaptor.

Order number	Description
CX1900-0101	Passive DVI-to-VGA adaptor for the connection of standard VGA monitors to the CX system – feeds out the VGA signals of the DVI-I interface of the CX module – DVI-A plug, 29-pin (bottom), socket, 15-pin (top) – Weight: approx. 40 g – Dimensions (W x H x D): 40 x 42 x 15 mm

Table 46: Spare battery for CX systems.

Order number	Description
CX1900-0102	Battery for CX systems Original manufacturer's designation: Panasonic type CR2032 3V/225 mAh

Table 47: Other spare parts.

Order number	Description
CX2900-0101	Housing locking clips (black) for the CX20x0 series. 10 locking pin sets (each set consisting of two pieces).
CX2900-0102	Cover for left-side module bus connector, 5 pieces
CX2900-0103	Spare fan cartridge for CX2040, CX2042, CX2062, CX2072 and CX2020, CX2030 with fan option – cartridge consisting of chassis and 60 mm fan – simple exchange in the field due to wireless installation – Weight: approx. 30 g – dimensions (W x H x D) 67 x 62 x 16 mm

## 13.2 Certifications

All products of the Embedded PC family are CE, UL and EAC certified. Since the product family is continuously developed further, we are unable to provide a full listing here. The current list of certified products can be found at [www.beckhoff.com](http://www.beckhoff.com).

### **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.

## 13.3 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.

### Beckhoff's branch offices and representatives

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

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