

Manual | EN

CX20x0

Embedded PC



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

EP1590927, EP1789857, EP1456722, EP2137893, DE102015105702
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1.1 Representation and structure of warnings

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

Warnings relating to personal injury:

DANGER

Hazard with high risk of death or serious injury.

WARNING

Hazard with medium risk of death or serious injury.

CAUTION

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

Warnings relating to damage to property or the environment:

NOTE

There is a potential hazard to the environment and equipment.

Notes showing further information or tips:



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

1.2 Related documents

This documentation considers and describes material that is relevant for the Embedded-PC CX20x0. The Embedded-PC CX20x0 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
CX2100-09x4 UPS power supply unit for CX20x0

Retaining the documentation

This documentation is part of the Embedded-PC. Keep the documentation in the immediate vicinity of the battery pack 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
1.1	Notes on power connections added, order numbers for CX20x0-N031 added
1.2	New types added
1.3	UL requirements added
1.4	Chapter "DVI-D port" and "module overview" added.
1.5	Chapter "Types" reworked.
1.6	Chapter "NOVRAM" and "USV (persistent data)" added.
1.7	Documentation restructured and revised.
1.8	Chapter „Using a hardware watchdog“ added.
1.9	Chapter Beckhoff Device Manager revised
2.0	Chapter "Observe the UL requirements" added.
2.1	Chapter "Selecting the appropriate CX2100 power supply unit" und "Technical data" revised.
2.2	Chapter "Types" and "Device Manager" revised.
2.3	Chapter "TwinCAT" revised.
2.4	Chapter "Commissioning" revised.
2.5	Integrated CFast cards adapted from 4 GB and 8 GB to 20 GB and 40 GB

2 For your safety

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

Limitation of liability

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

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

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

2.1 Intended use

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

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

Improper use

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

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

2.2 Staff qualification

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

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

2.3 Safety instructions

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

Mounting

- Never work on live equipment. Always switch off the power supply for the device before installation, troubleshooting or maintenance. Protect the device against unintentional switching on.
- Observe the relevant accident prevention regulations for your machine (e.g. the BGV A 3, electrical systems and equipment).
- Ensure standard-compliant connection and avoid risks to personnel. Ensure that data and supply cables are laid in a standard-compliant manner and ensure correct 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.
- Protect the devices with a firewall.
- Apply the IT security precautions according to IEC 62443, in order to limit access to and control of devices and networks.

Working with the software

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

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

<http://infosys.beckhoff.com>

Document name
IPC Security Guideline

2.4 Notes on information security

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

In addition, the recommendations from Beckhoff regarding appropriate protective measures should be observed. Further information regarding information security and industrial security can be found in our <https://www.beckhoff.com/secguide>.

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

To stay informed about information security for Beckhoff products, subscribe to the RSS feed at <https://www.beckhoff.com/secinfo>.

3 Transport and storage

Transport

NOTE

Short circuit due to moisture

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

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

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

- mechanical stress and
- use the original packaging.

Table 1: Dimensions and weight of the individual modules.

	CX2020	CX2030	CX2040
Dimensions (W x H x D)	144 mm x 99 mm x 91 mm		
Weight	approx. 1160 g	approx. 1165 g	approx. 1230 g

Storage

- Remove the battery from the Embedded PC if storage temperatures exceed 60 °C. The battery should be stored separate from the Embedded PC in a dry environment at a temperature between 0 °C and 30 °C.

The preset date and time are lost if the battery is removed.

4 Product overview

The 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.

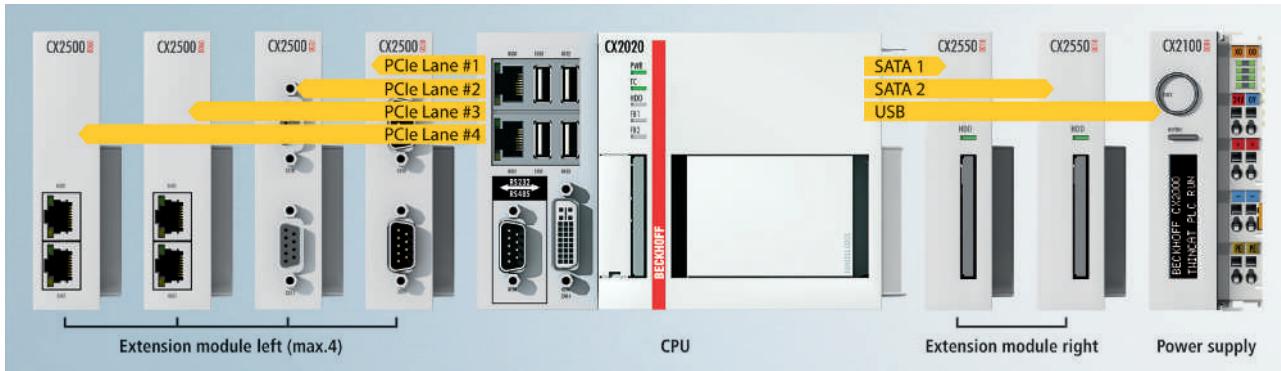


Fig. 1: Overview of the CX2000 product family with basic CPU module, power supply unit and modules.

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 CX2000 Embedded PC includes:

- a CFast card slot,
- two independent Gbit Ethernet interfaces,
- four USB 2.0 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.

Suitable operating systems are Microsoft Windows 10 IoT Enterprise LTSB, Microsoft Windows Embedded Standard 7 P or Microsoft Windows Embedded Compact 7.

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 CX20x0.

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-pin.
CX20x0-N031	RS422/RS485, D-sub socket, 9-pin.
CX20x0-B110	EtherCAT slave, EtherCAT IN and OUT (2 x RJ45).
CX20x0-M310	PROFIBUS master, D-sub socket, 9-pin.
CX20x0-B310	PROFIBUS slave, D-sub socket, 9-pin.
CX20x0-M510	CANopen master, D-sub connector, 9-pin.
CX20x0-B510	CANopen slave, D-sub connector, 9-pin.
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 power supply units are available in four different versions:

- CX2100-0004: E-bus/K-bus power supply unit with automatic switchover.
- CX2100-0014: E-bus/K-bus power supply unit with automatic switchover and passive ventilation.
- CX2100-0904: E-bus/K-bus power supply unit with automatic switchover and integrated capacitive UPS.
- CX2100-0914: E-bus/K-bus power supply unit with automatic switchover and integrated electronic charging unit for an external battery pack.

All 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-pin 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.

CX2900 battery pack

The battery pack is a charge store for the CX2000 product family and used as UPS in conjunction with the CX2100-0914 power supply unit. In the event of a power failure the battery pack supplies the basic CPU module and further devices (e.g. a Panel) via the CX2100-0914 power supply unit.

Software

In combination with the TwinCAT automation software, the CX20x0 Embedded PC becomes a powerful IEC 61131-3 PLC with up to four user tasks. 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

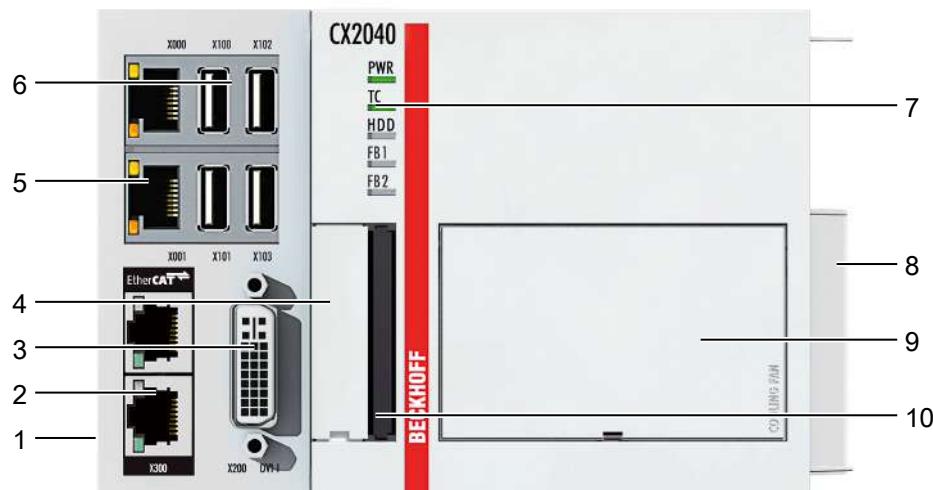


Fig. 2: Example: Embedded PCs CX2040 with active cooling.

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

No.	Component	Description
1	Multi-pin connection (left)	Extension through system modules and fieldbus modules of type CX2500.
2	Optional interface (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 (X200).	Interface for a monitor or Panel.
4	<u>Battery compartment</u> [▶ 78] (under the front flap).	Power supply for the battery-backed clock for time and date.
5	RJ45 Ethernet interfaces (X000, X001).	For connecting to local networks, internet or EtherCAT.
6	USB interfaces (X100, X101, X102, X103).	Interfaces for peripherals such as mouse, keyboard or USB memory.
7	<u>Diagnostic LEDs.</u> [▶ 73]	Diagnostic LEDs for power supply, TwinCAT, CFast card and optional interface.
8	Multi-pin connection (right)	Connection for extension modules of type CX2550 and for power supply units of type CX2100.
9	<u>Fan cartridge</u> [▶ 78] (under the front flap).	The fan cartridge is provided as standard for the CX2040. The CX2020 and CX2030 can be ordered with active cooling ex factory.
10	CFast card slot.	Slot for industrial CFast cards.

4.2 Name plate

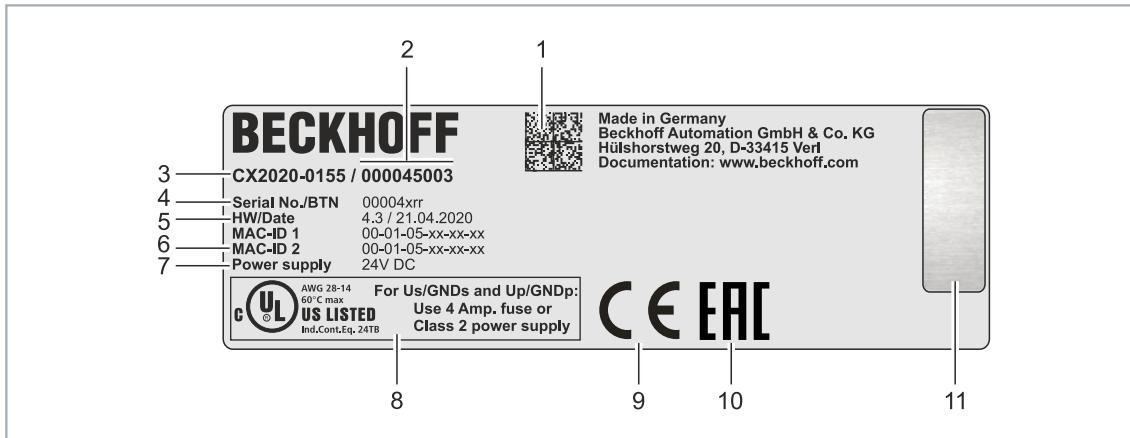


Fig. 3: Name plate example.

Table 4: Information on the name plate.

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

4.3 Types

The 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.

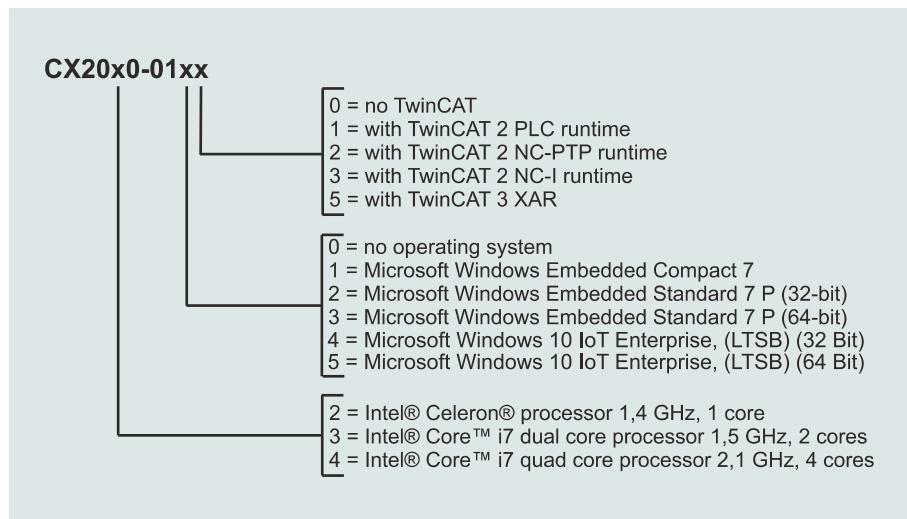


Fig. 4: Nomenclature for the basic CPU module.

The basic CPU module CX2020, CX2030 and CX2040 is available with the following software options:

Table 5: CX20x0, ordering information for software.

Module	no operating system	Windows Embedded Compact 7	Windows Embedded Standard 7 P (32-Bit)	Windows Embedded Standard 7 P (64-Bit)	Windows 10 IoT Enterprise, 32 Bit	Windows 10 IoT Enterprise, 64 Bit	no TwinCAT	TwinCAT 2 PLC-Runtime	TwinCAT 2 NC-PTP-Runtime	TwinCAT 2 NC-I-Runtime	TwinCAT 3 XAR
CX20x0-0100	X	-	-	-	-	-	X	-	-	-	-
CX20x0-0110	-	X	-	-	-	-	X	-	-	-	-
CX20x0-0111	-	X	-	-	-	-	-	X	-	-	-
CX20x0-0112	-	X	-	-	-	-	-	-	X	-	-
CX20x0-0113	-	X	-	-	-	-	-	-	-	X	-
CX20x0-0115	-	X	-	-	-	-	-	-	-	-	X ¹⁾
CX20x0-0120	-	-	X	-	-	-	X	-	-	-	-
CX20x0-0121	-	-	X	-	-	-	-	X	-	-	-
CX20x0-0122	-	-	X	-	-	-	-	-	X	-	-
CX20x0-0123	-	-	X	-	-	-	-	-	-	X	-
CX20x0-0125	-	-	X	-	-	-	-	-	-	-	X
CX20x0-0130	-	-	-	X	-	-	X	-	-	-	-
CX20x0-0135	-	-	-	X	-	-	-	-	-	-	X
CX20x0-0140	-	-	-	-	X	-	X	-	-	-	-
CX20x0-0141	-	-	-	-	X	-	-	X	-	-	-
CX20x0-0142	-	-	-	-	X	-	-	-	X	-	-
CX20x0-0143	-	-	-	-	X	-	-	-	-	X	-
CX20x0-0150	-	-	-	-	-	X	X	-	-	-	-
CX20x0-0155	-	-	-	-	-	X	-	-	-	-	X

¹⁾ TwinCAT 3 supports only one CPU core. Applies to CX2030 and CX2040.

A CX20x0 Embedded PC with Microsoft Windows Embedded Compact 7 requires a CFast card with a minimum capacity of 20 GB. For Microsoft Windows Embedded Standard 7 P and Microsoft Windows 10 IoT Enterprise a CFast card with a minimum capacity of 40 GB is required.

4.4 Architekture overview

The Embedded PCs of the CX20x0 family all have the same architecture. The architecture is described below.

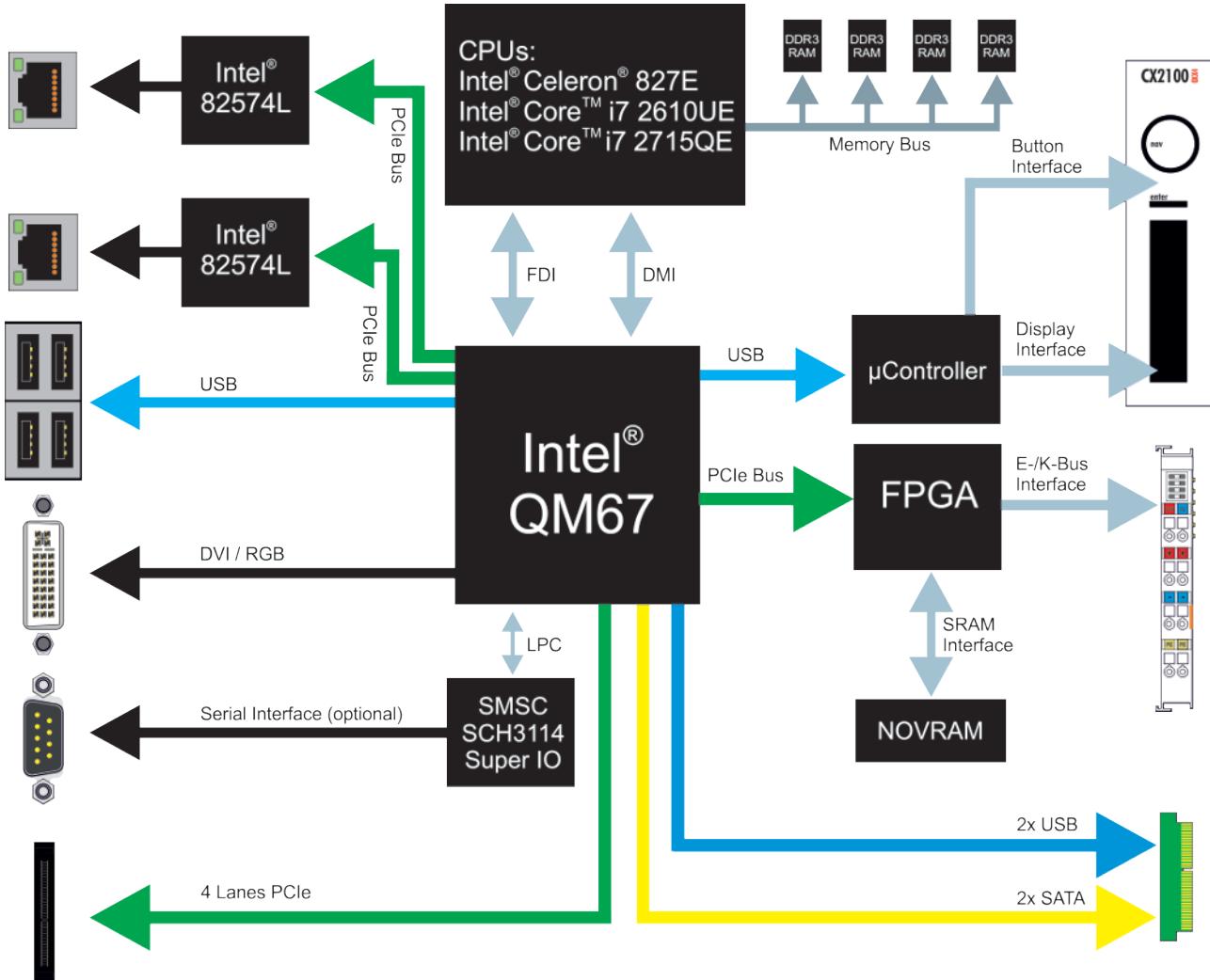


Fig. 5: CX20x0 architecture overview.

The CX20x0 Embedded PCs are based on the Sandy Bridge microarchitecture developed by Intel. The following CPUs are used:

- Intel®Celeron® 827E (Singlecore),
- Intel®CORE™ i7 2610UE (Dualcore),
- and Intel®Core™ i7 2715QE (Quadcore).

In addition to the arithmetic unit, the CPU also contains the memory controller and the graphics controller. The single-core processor uses the Intel® HD has as graphics core. The two Core™ i7 CPUs (dual or quad core) feature an Intel® HD graphics 3000 core. This offers a somewhat higher performance than the Intel® HD graphics core, and the quad core offers a higher clock speed. For details on the CPUs please refer to Intel. The memory is connected directly to the memory controller. The Embedded PCs are available in two memory configurations: 2GB or 4GB DDR3 RAM. The memory is not expandable and must be ordered ex factory.

All CX20x0 Embedded PCs use the Mobile Intel® QM67 Express chipset (Intel® BD82QM67 PCH). This chip provides all required interfaces:

- 4 x USB 2.0
- 1x USB 2.0 internal (power supply unit control button / display).
- DVI-I and DVI-D interface (second interface optional CX20x0-N010).

- 1 PCIe lane for each of the two Intel® 82574L Gigabit Ethernet controllers
- LPC interface for super I/O controller for serial interface (CX20x0-N03x).
- 4 PCIe lanes via the multi-pin 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-pin 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® 82574L 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 Interface description

5.1 USB (X100, X101, X102, X103)

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

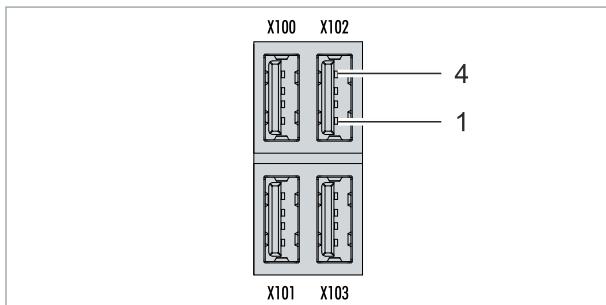


Fig. 6: USB interfaces (X100, X101, X102, X103).

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

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

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

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

5.2 Ethernet RJ45 (X000, X001)

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

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

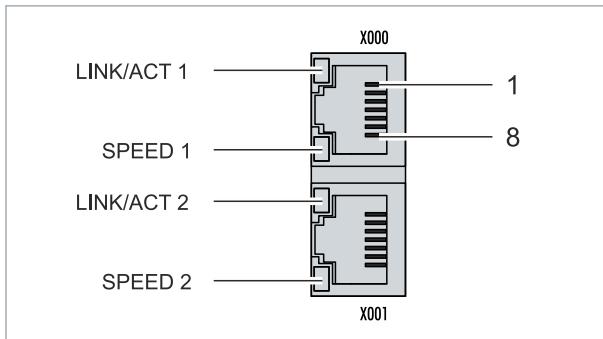


Fig. 7: Ethernet interfaces X000, X001.

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

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

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

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

5.3 DVI-I (X200)

The DVI-I interface (X200) transfers digital data and is suitable for connection to digital or analog monitors. The resolution 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.

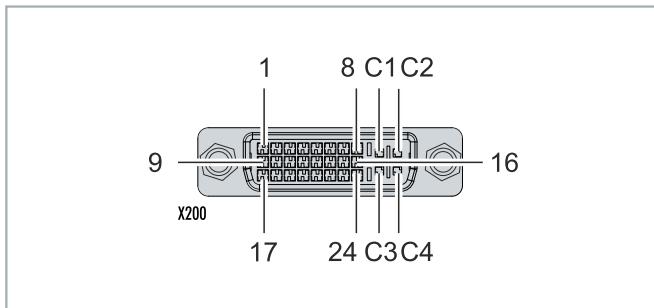


Fig. 8: DVI-I interface X200.

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

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

Table 9: DVI-I cross, pin assignment.

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

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

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

The Embedded PC also supports higher resolutions, based on the DVI standard. A maximum resolution of 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

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

5.4.1 DVI-D (N010)

The DVI-D interface (X300) transfers digital data and is suitable for connection to digital displays. 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.

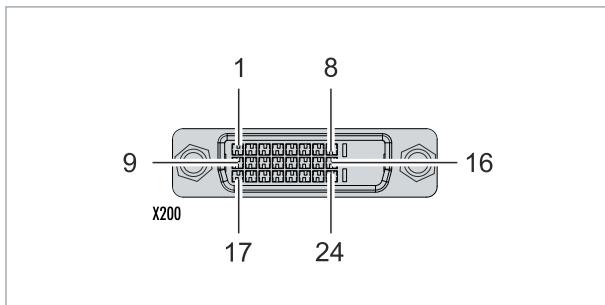


Fig. 9: DVI-D interface X300.

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

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

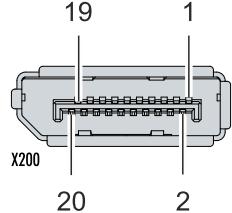


Fig. 10: DisplayPort X300.

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	Connection	Pin	Connection
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. 2560x1600@60Hz
DisplayPort with adapter, DisplayPort to DVI-D	max. 1600x1200@60Hz

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.

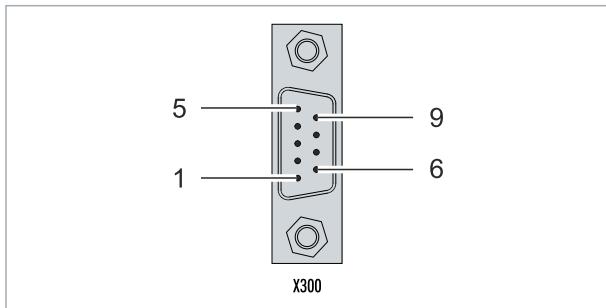


Fig. 11: RS232 interface X300.

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

Table 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 executed on a 9-pin D-sub socket.

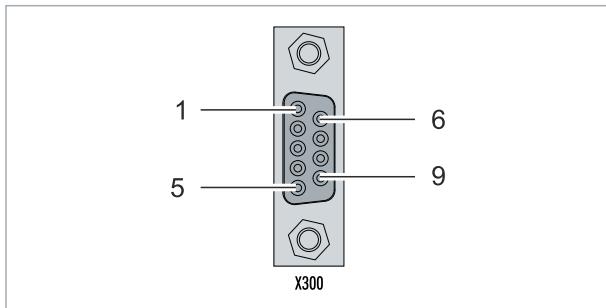


Fig. 12: RS485 interface X300.

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

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

By default the interface is parameterized as follows on delivery:

Table 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.

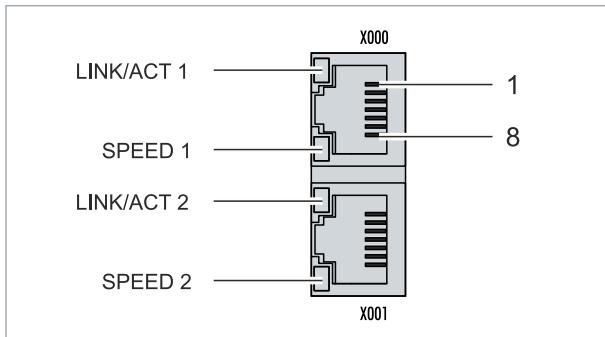


Fig. 13: EtherCAT slave interface X300.

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

Table 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 EtherCAT slave optional interface (B110), documentation with further information is available:

https://infosys.beckhoff.com/content/1033/b110_ethercat_optioninterface/index.html?id=2623834056269338700

Document name
CXxxxx-B110 EtherCAT Slave Optional Interface.

5.4.6 PROFIBUS (x310)

Pin 6 transfers 5 V_{DC} , 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.

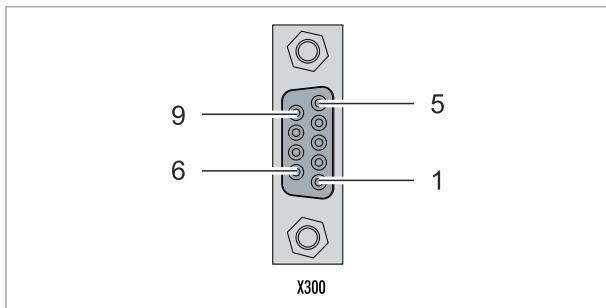


Fig. 14: PROFIBUS interface X310.

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	Connection
1	Shielding
2	not used
3	RxD/TxD-P
4	not used
5	GND
6	$+5 \text{ V}_{\text{DC}}$
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 PROFIBUS optional interface (x310), documentation with further information is available:

https://infosys.beckhoff.com/content/1033/m310_b310_profibus_optioninterface/index.html?id=2233561431434830097

Document name
CXxxxx-M310/B310 Profibus Optional Interface

5.4.7 CANopen (x510)

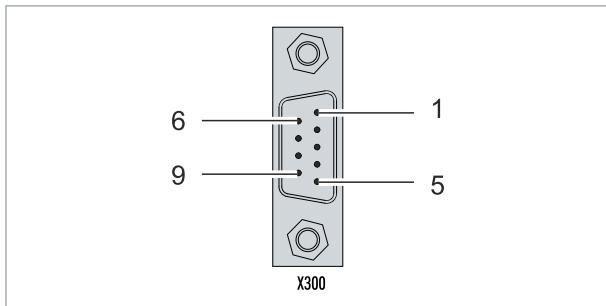


Fig. 15: CANopen interface X510.

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

Table 21: CANopen interface X510, pin assignment.

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

For the CANopen optional interface (x510), documentation with further information is available:

https://infosys.beckhoff.com/content/1033/m510_b510_canopen_optioninterface/index.html?id=1404127979601372947

Document name

CXxxxx-M510/B510 | CANopen Optional Interface

5.4.8 PROFINET RT (x930)

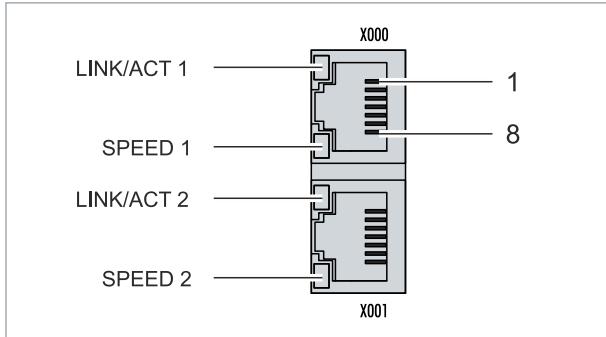


Fig. 16: PROFINET RT interface X300.

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		

For the PROFINET RT optional interface (x930), documentation with further information is available:

https://infosys.beckhoff.com/content/1033/m930_b930_profinet_optioninterface/index.html?id=3617310193267164961

Document name
CXxxxx-M930/B930 Profinet Optional Interface

6 Commissioning

6.1 Selecting the appropriate CX2100 power supply unit

The basic CPU module requires a power supply unit of type CX2100-0xxx. Connect the power supply unit to the multi-pin port on the right of the basic CPU module.

When selecting a CX2100-0xxx power supply unit, always check whether the peak power consumption of the overall system with all connected USB devices, expansion, system and fieldbus modules can be covered by the selected power supply unit.

In horizontal installation position, any CX2100-0xxx power supply unit can be used.

Table 23: Power supply units for horizontal installation position.

Basic CPU module	Power supply units
CX2020	<ul style="list-style-type: none"> • CX2100-0004 (45 W)
CX2030	<ul style="list-style-type: none"> • CX2100-0014 (130 W, from HW version: 2.4) • CX2100-0904 (45 W, capacitive UPS) • CX2100-0914 (100 W, external battery pack can be used) • CX2100-0024 (240 W)
CX2040	<ul style="list-style-type: none"> • CX2100-0014 (130 W, from HW version: 2.4) • CX2100-0914 (100 W, external battery pack can be used) • CX2100-0024 (240 W)

The Embedded PCs CX2020 and CX2030 can be ordered with active cooling ex factory, for operation in vertical or horizontal installation position. In this case only CX2100-0014 or CX2100-0914 power supply units should be used, which feature additional ventilation openings and larger heat sinks.

The Embedded PC CX2040 is equipped with a fan cartridge as standard. It can be operated in vertical or horizontal installation position and requires power supply units of type CX2100-0014 or CX2100-0914.

Table 24: Power supply units for vertical or horizontal installation position.

Basic CPU module	Accessories	Power supply units
CX2020	CX2900-0200 fan option required	<ul style="list-style-type: none"> • CX2100-0014 (130 W)
CX2030		<ul style="list-style-type: none"> • CX2100-0914 (100 W, external battery pack can be used)
CX2040	Fan ex factory	<ul style="list-style-type: none"> • CX2100-0024 (240 W)

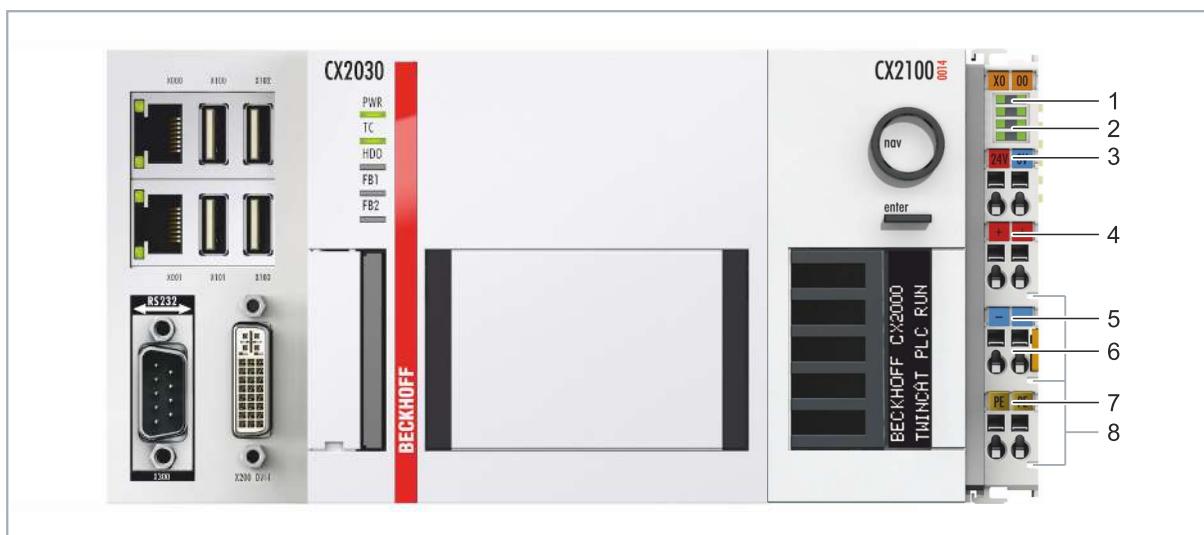
Configuration of the power supply terminal

Fig. 17: Embedded PC CX20x0 with power supply unit CX2100-0014, configuration of the power supply terminal.

Table 25: 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-bus 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

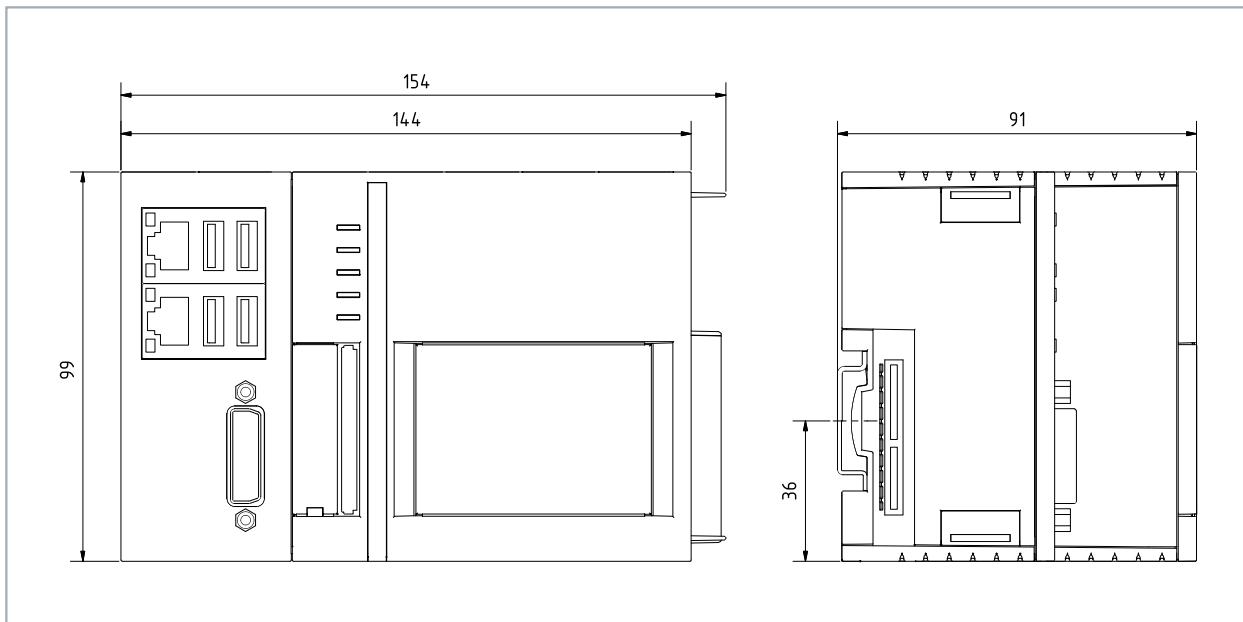


Fig. 18: CX2020 and CX2030 Embedded PC, dimensions.

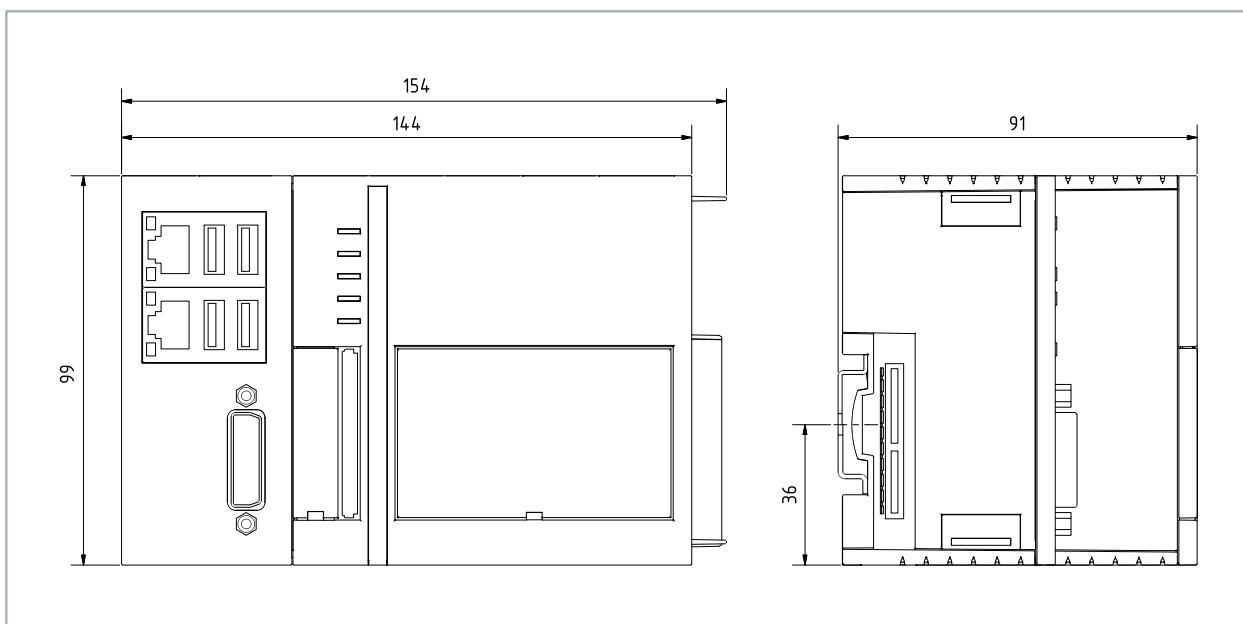


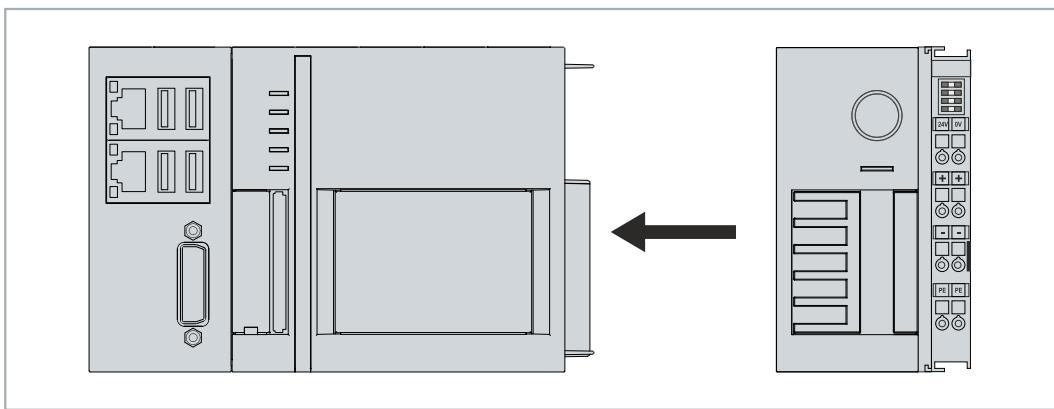
Fig. 19: CX2040 Embedded PC, dimensions.

6.2.1 Attaching the power supply unit

The basic CPU module requires a power supply unit of type CX2100-0xxx. Connect the power supply unit to the multi-pin port on the right of the basic CPU module.

Proceed as follows:

1. Select the appropriate power supply unit, as described in chapter [Selecting the appropriate CX2100 power supply unit \[▶ 32\]](#).
2. Attach the power supply unit on the right of the basic CPU module.



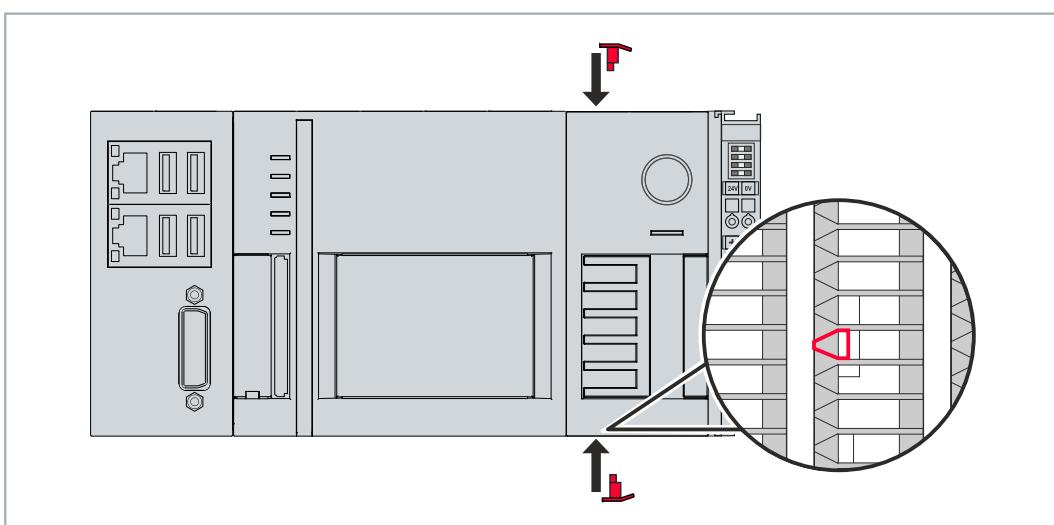
⇒ Next you can install the bar clips.

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

Overheating

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

Install the Embedded PC horizontally in the control cabinet on a mounting rail, in order to ensure optimum heat dissipation. Only Embedded PCs with active cooling can be operated vertically or horizontally.

Table 26: Embedded PC CX20x0, installation position depending on the cooling option.

Embedded PCs	Horizontal installation position	Vertical and horizontal installation position
CX2020	X	-
CX2030	X	-
CX2040 with active cooling	X	X
CX2020 with CX2900-0200 fan option	X	X
CX2030 with CX2900-0200 fan option	X	X

Note the following specifications for the control cabinet:

- The Embedded PC should only be operated at ambient temperatures between -25 °C and 60 °C. Measure the temperature below the Embedded PC at a distance of 30 mm to the cooling fins, in order to determine the ambient temperature correctly.
- Adhere to the minimum distances of 30 mm above and below the Embedded PC.
- Additional electrical equipment affects the heat generation in the control cabinet. Select a suitable control cabinet enclosure depending on the application, or ensure that excess heat is dissipated from the control cabinet.

Permitted installation position without fan

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

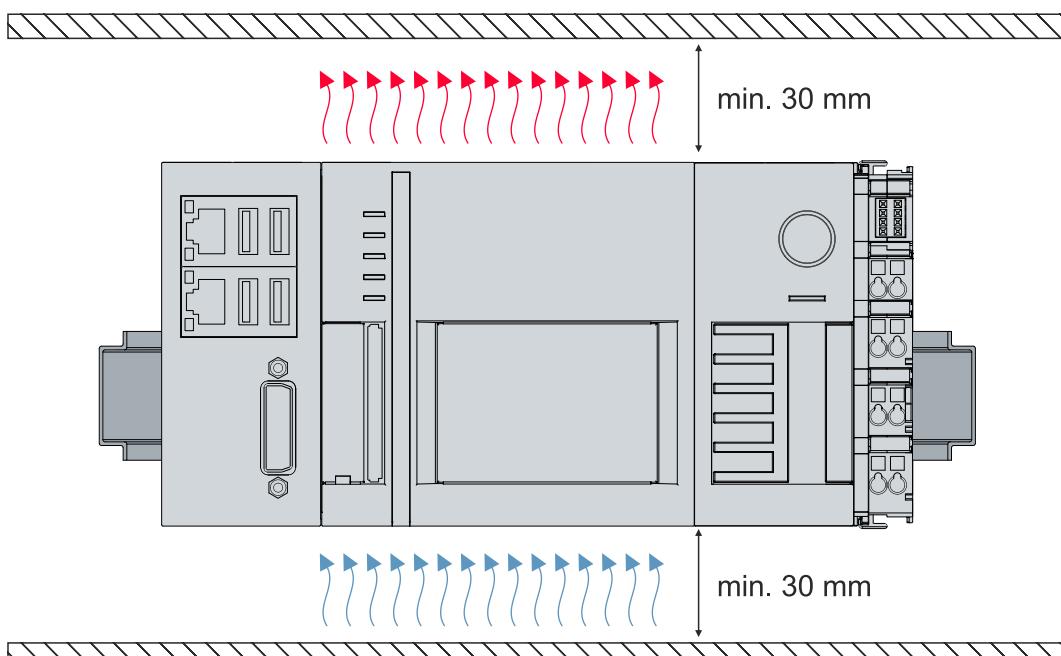


Fig. 20: Embedded PC CX20x0, horizontal installation position.

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

Permitted installation positions with fan

Only Embedded PCs with an active cooling can be installed vertically or horizontally on the mounting rail. Without active cooling the Embedded PC is not ventilated adequately in vertical or horizontal position.

Even with active cooling, the ambient temperature range between -25 and 60 °C and the minimum distances of 30 mm above and below the Embedded PC should be adhered to. Secure the Embedded PC with an additional bracket, in order to prevent it slipping from the DIN rail.

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

6.2.4 Attaching on mounting rail

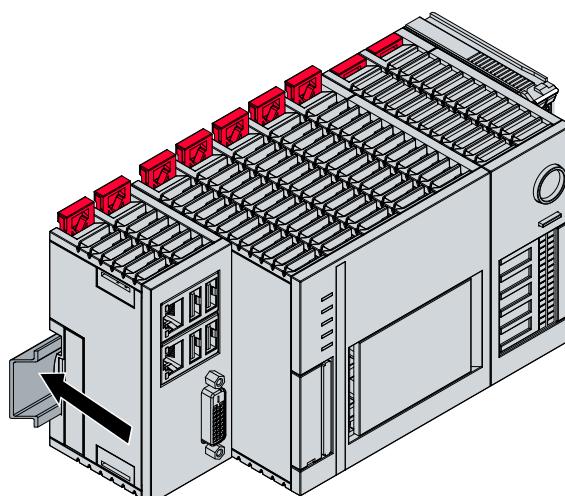
The housing is designed such that the Embedded PC can be pushed against the mounting rail and latched onto it.

Requirements:

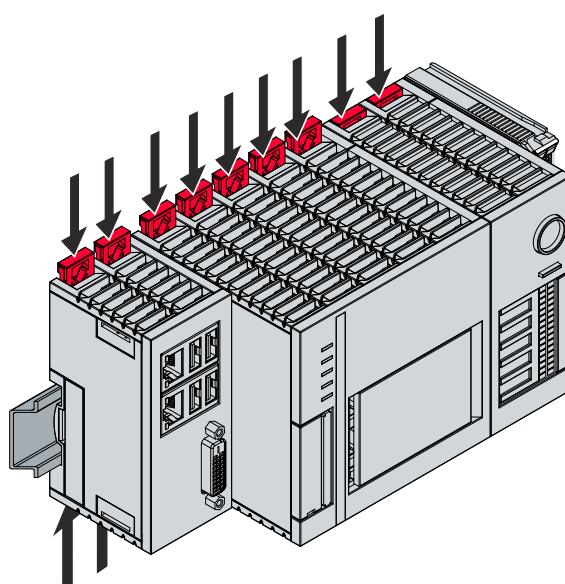
- Mounting rail of type TS35/7.5 or TS35/15 according to DIN EN 60715.

Secure the Embedded PC on the mounting rail as follows:

1. Unlock the latches on the top side and underside using a screwdriver.
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



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).

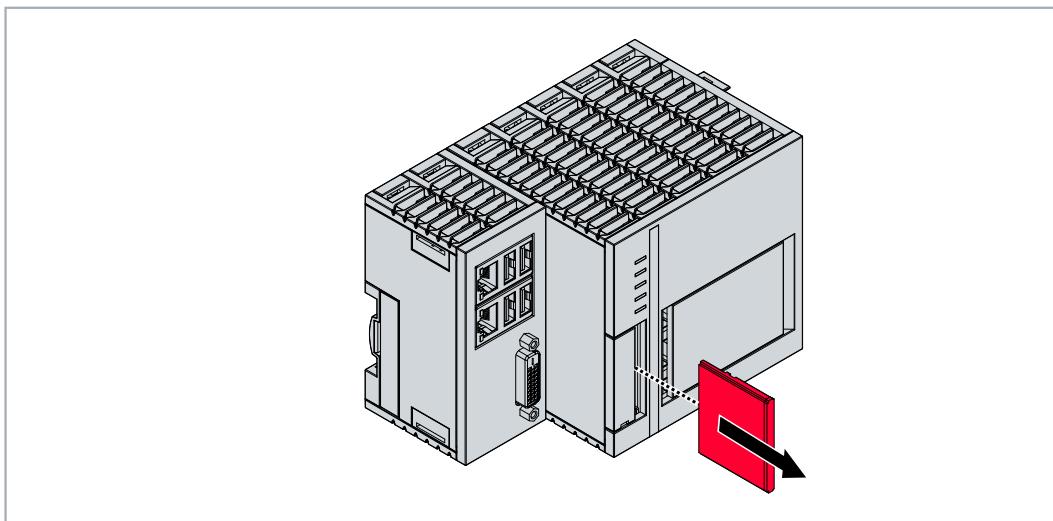
The eject mechanism is based on the push/push principle. The installation and removal of CFast cards is described below.

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



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.

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

Fig. 21: 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.

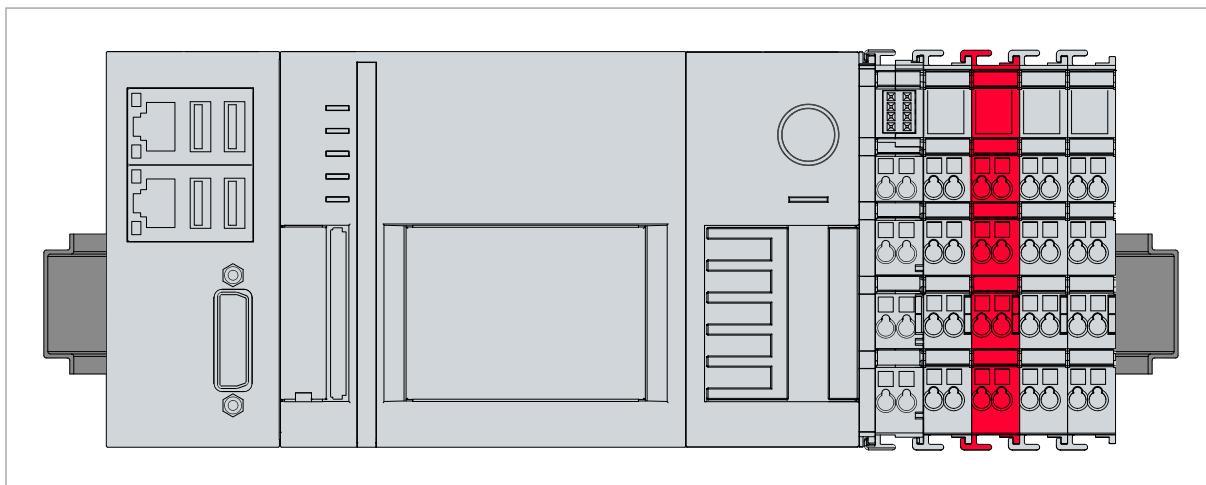


Fig. 22: Passive EtherCAT Terminals, permissible installation.

6.3 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 power supply units require an external voltage source, which provides 24 V DC (-15% / +20%).

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 one point of the energy source for this circuit must be connected to the protective earth conductor system.

Connection example with basic CPU module CX20x0 and CX2100-0014 power supply unit:

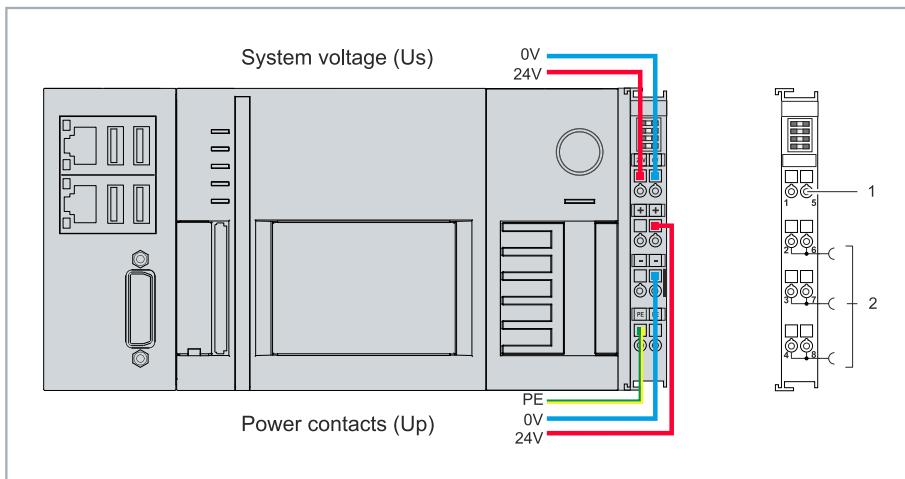


Fig. 23: Connections for system voltage (Us) and power contacts (Up).

Table 27: 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.

Fuse

- When dimensioning the fuse for the system voltage (Us), observe the maximum power consumption of the Embedded PC (see: [Technical data \[► 83\]](#)).
- Protect the power contacts (Up) with a fuse with a max. rating of 10 A (slow-blow).

Interrupting/swinging 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 has (no potential difference).

6.3.1 Connect Embedded PC

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

Table 28: Required conductor cross-sections and strip lengths.

Conductor cross-section	0.5 ... 2.5 mm ²	AWG 20 ... AWG 14
Strip length	8 ... 9 mm	0.33 inch

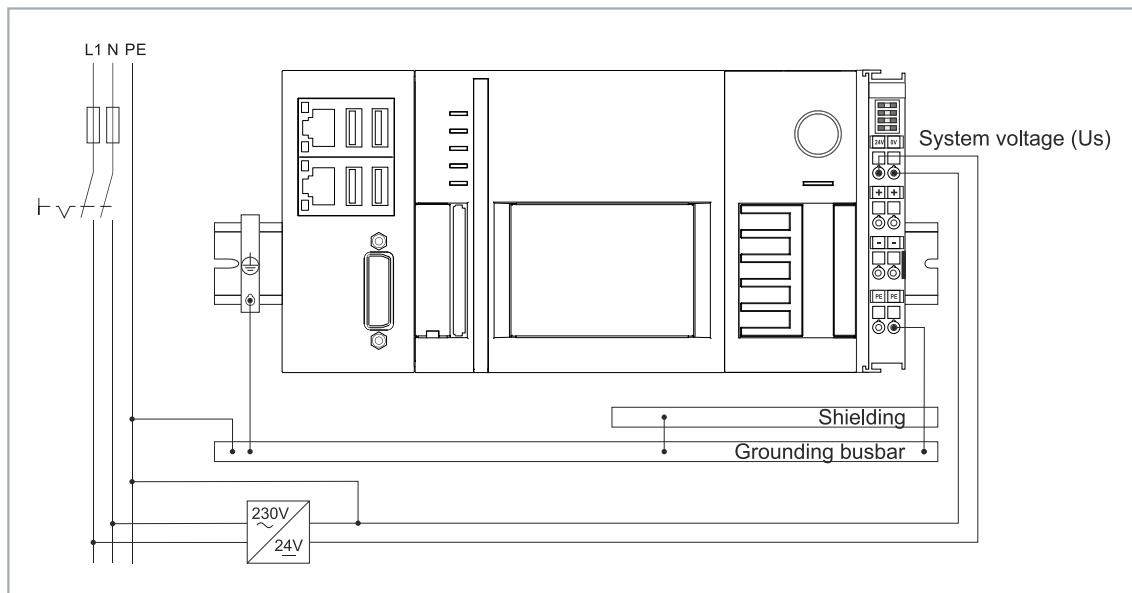
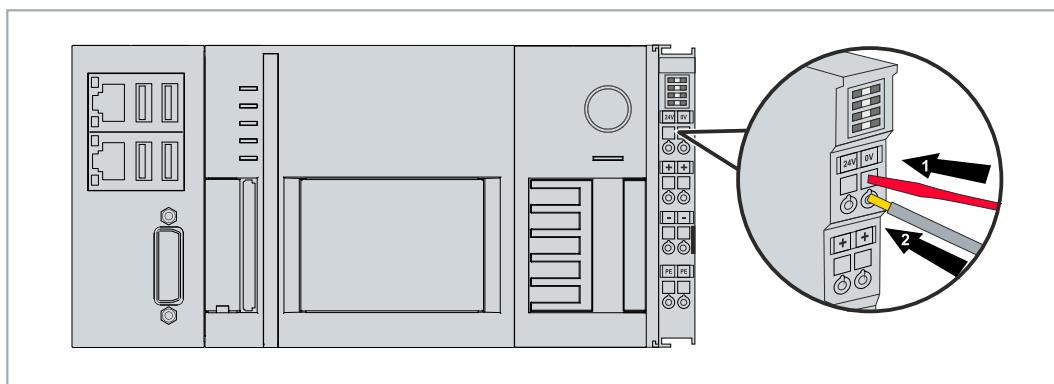


Fig. 24: Connection example with a CX20x0.

Connect the Embedded PC as follows:

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



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

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

6.3.2 UL requirements

The CX20x0 Embedded PCs are UL-certified. The corresponding UL label can be found on the name plate.



Fig. 25: UL label for CX20x0.

The Embedded PCs CX20x0 can thus be used in areas in which special UL requirements have to be met. These requirements apply to the system voltage (Us) and the power contacts (Up). Applications without special UL requirements are not affected by UL regulations.

UL requirements:

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

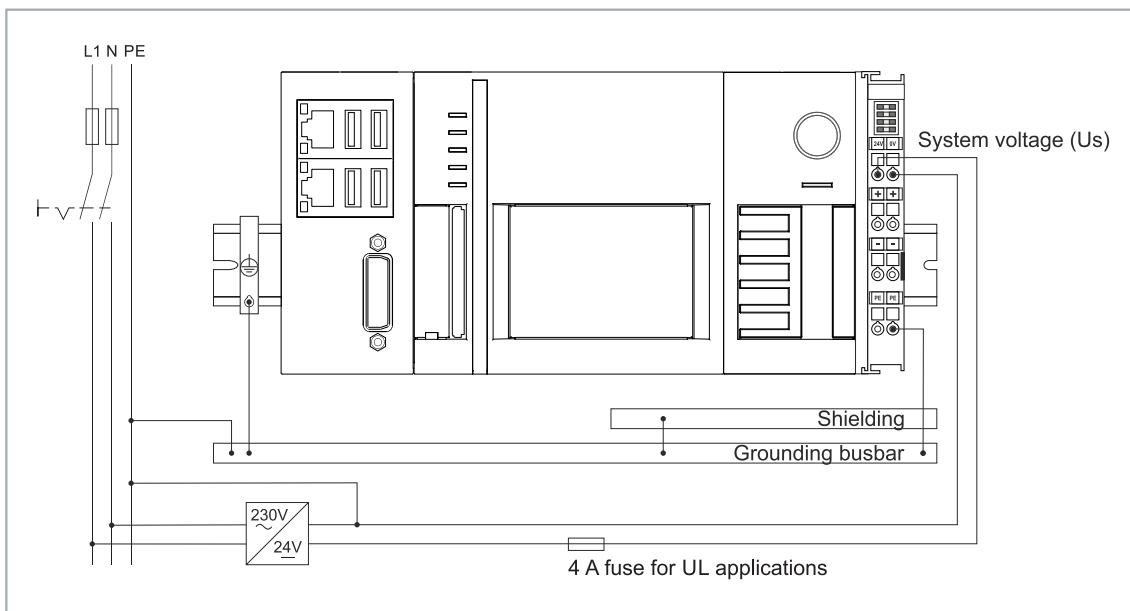


Fig. 26: Connection example for areas with special UL requirements.

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 right CX2100 power supply unit and the right installation position were selected.
3. Check whether the Embedded PC is mounted securely on the DIN rail and all required Bus Terminals are connected.
4. Only then switch on the power supply for the power supply unit.
⇒ The Embedded PC starts automatically when the external power supply is switched on. The pre-installed operating system is started and all connected extension, system and fieldbus modules are configured.

6.5 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 from the power supply 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 Embedded Compact 7

7.1.1 Scan for new hardware

Under Windows Embedded Compact 7 the Embedded PC scans for new hardware on the PCI bus the first time it is started. After that the hardware is permanently registered and the saved configuration is used.

If other extension modules are plugged in after the first start, the Embedded PC no longer scans for new hardware and the new extension modules will not be found.

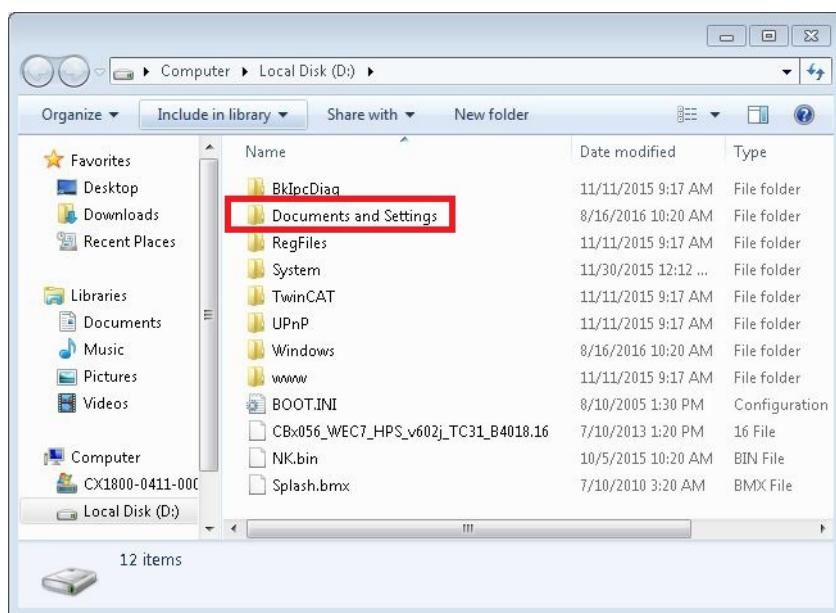
Follow these steps to ensure that an Embedded PC running Windows Embedded Compact 7 scans for new hardware again.

Requirements:

- Windows Embedded Compact 7

Proceed as follows:

1. Switch the Embedded PC off and remove the CFast card from the Embedded PC.
2. Insert the CFast card into an external card reader and open the CFast card's folder structure.
3. Delete the **Documents and Settings** folder on the CFast card.



4. Install the CFast card in the Embedded PC again.

5. Start the Embedded PC.

⇒ After starting, the Embedded PC scans for new hardware once again and saves the current hardware configuration.

As soon as you change the hardware and plug in other extension modules, you must repeat these steps and delete the **Documents and Settings** folder again.

7.2 Windows Embedded Standard 7 P

7.2.1 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:

- Local Area Connection 2 corresponds to Ethernet interface X000.
- Local Area Connection corresponds to Ethernet interface X001.

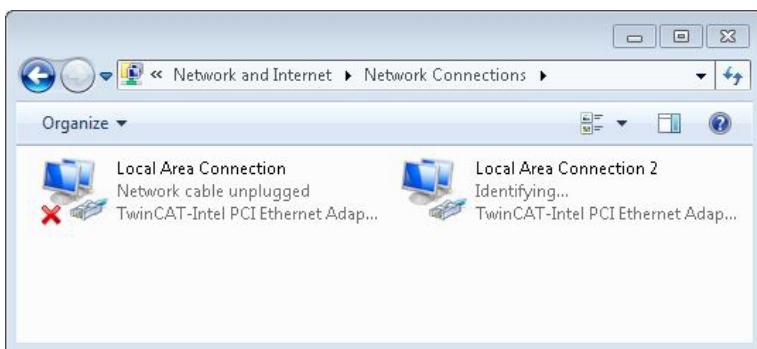


Fig. 27: Windows 7, Identification of the Ethernet interfaces (X000, X001) in the Network and Sharing Center.

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

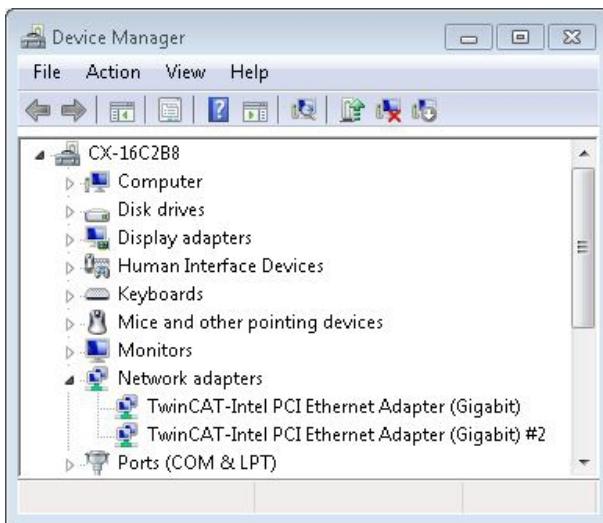


Fig. 28: Windows 7, identification of the Ethernet interfaces (X000, X001) in the device manager.

7.2.2 Enabling jumbo frames

Standardized Ethernet frames have a size of 1518 bytes. Ethernet frames that are larger than 1518 bytes are referred to as jumbo frames. Jumbo frames are used for transferring large data quantities. Jumbo frames are useful for certain applications, e.g. video cameras.

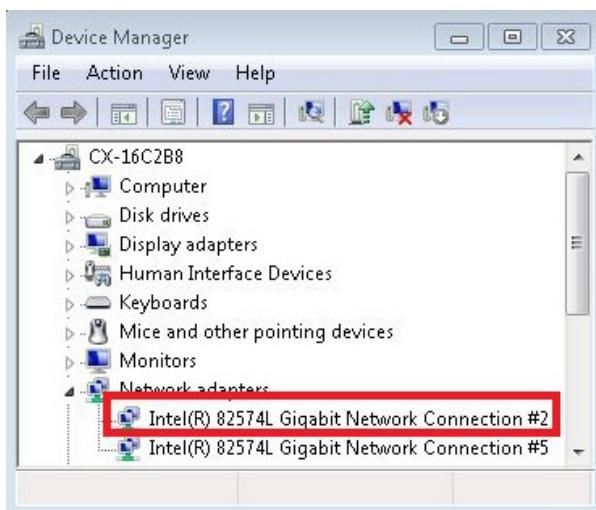
The Ethernet interfaces (X000, X001) support jumbo frames only if the original Intel® driver is installed.

Requirements:

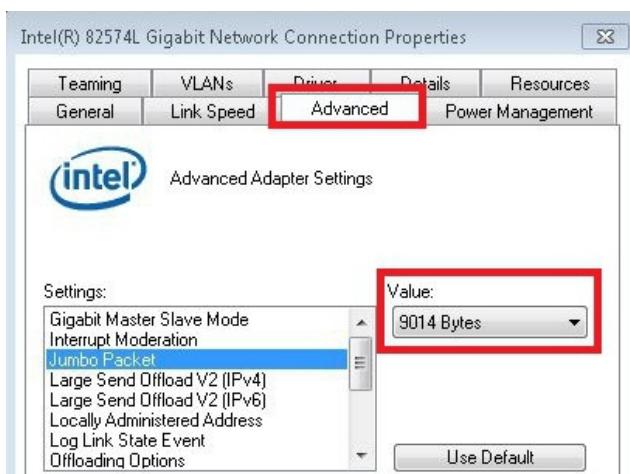
- The original Intel® driver can be downloaded from <https://downloadcenter.intel.com>.
- Install the original Intel® driver. Note that this will delete the real-time capable driver from Beckhoff.
- Check whether the peripheral devices support jumbo frames.

Jumbo frames are activated as follows:

1. Under **Start > Control Panel > Hardware and Sound** click on **Device Manager**.
2. Double-click on the interface and then on the **Advanced** tab.



3. Under **Settings** click on Jumbo Packet, under **Value** select the option 4088 bytes or 9014 bytes.



⇒ You have successfully activated jumbo frames, and you can now transfer larger data quantities.

7.2.3 Set NIC Teaming

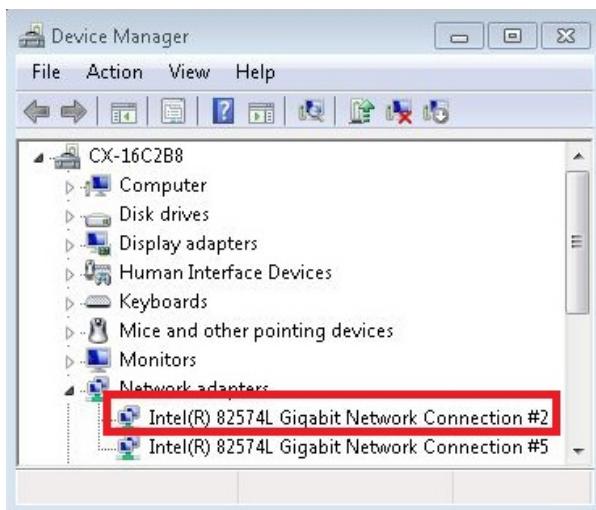
NIC Teaming consolidates several physical network cards to group, thereby creating redundancy. Redundancy can help intercept interference in network cards or in the cabling by assigning the data transfer to other devices in the group.

Requirements:

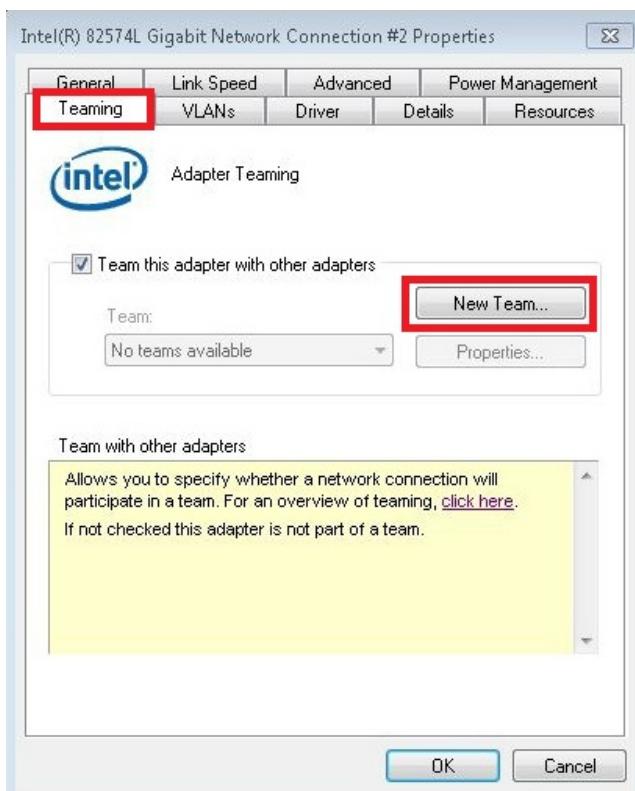
- The original Intel® driver can be downloaded from <https://downloadcenter.intel.com>.
- Install the original Intel® driver for the Network Interface Card. Note that this will delete the real-time capable driver from Beckhoff.

NIC Teaming is set as follows:

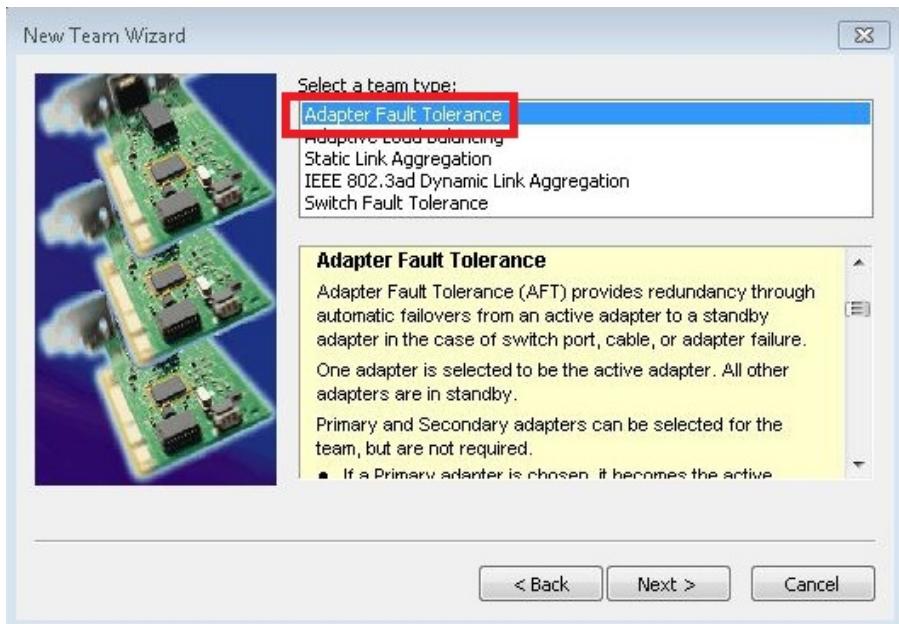
1. Under **Start > Control Panel > Hardware and Sound** click on **Device Manager**.
2. Double-click on the interface.



3. Click on the **Teaming** tab.
4. Click on **New Team** and follow the installation instructions.

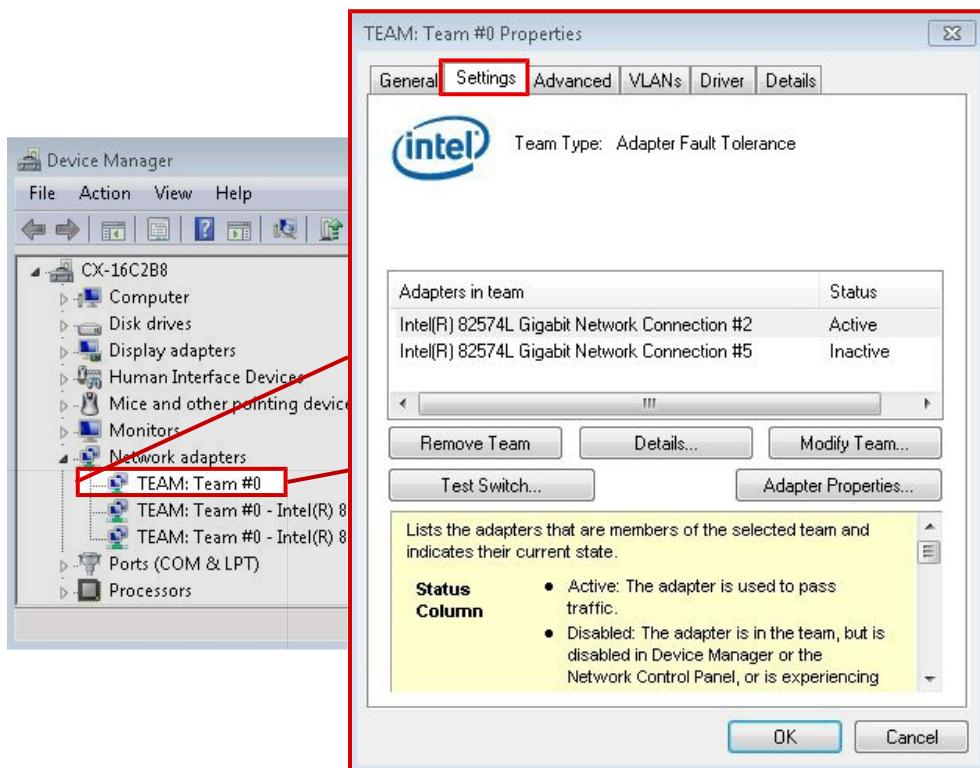


5. Under **Select a team type** select the option **Adapter Fault Tolerance**



6. Click on **Next** to complete the installation.

⇒ You have successfully set NIC Teaming for your Ethernet interfaces. Further settings can be specified or changed under the **Settings** tab.



7.2.4 Restoring the Beckhoff real-time driver.

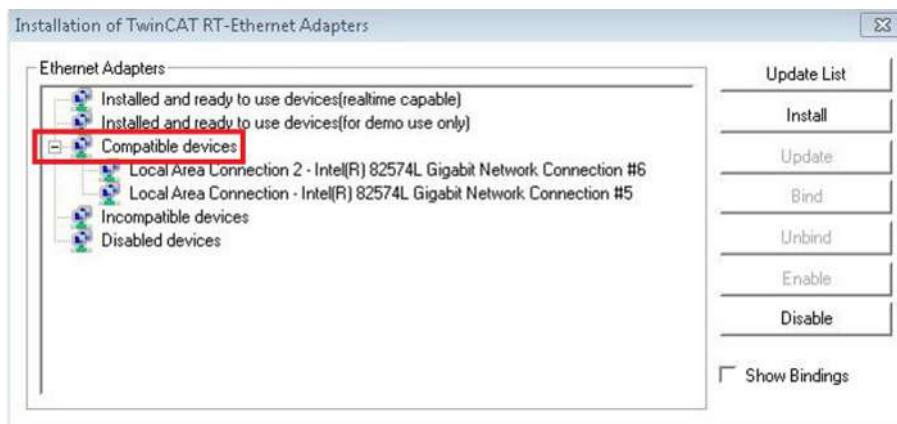
The Beckhoff real-time driver can be restored if the real-time driver was uninstalled or the original Intel® driver for jumbo frames or NIC Teaming was installed, for example. This chapter shows you how to use *TcRteInstall.exe* to restore the Beckhoff real-time driver. The file is in the TwinCAT directory by default.

Requirements:

- You can find the *TcRteInstall.exe* in a TwinCAT 2 standard installation under: C:\TwinCAT\lo\TcRteInstall.exe
- And in a TwinCAT 3 standard installation under: C:\TwinCAT\3.1\System\TcRteInstall.exe

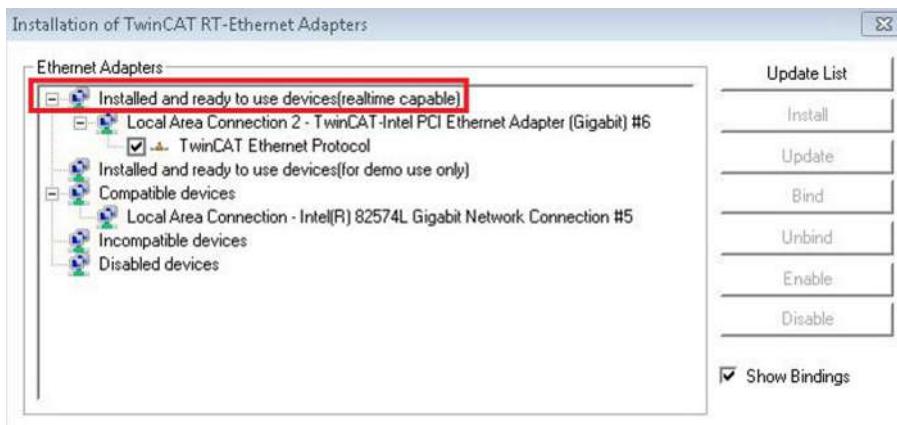
Proceed as follows:

1. Double-click the *TcRteInstall.exe* file.
The installation dialog appears and shows the compatible Ethernet interfaces under **Compatible devices**.



2. Select the Ethernet interfaces for which you wish to restore the Beckhoff real-time driver and click on **Install**.

⇒ The Beckhoff real-time driver is installed. The Ethernet interfaces with installed Beckhoff real-time driver are shown under **Installed and ready to use devices (real-time capable)**.



7.3 Windows 10 IoT Enterprise LTSB

7.3.1 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.

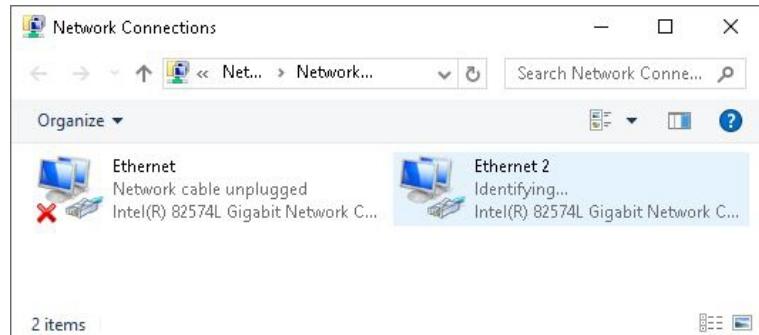


Fig. 29: Windows 10, Identification of the Ethernet interfaces (X000, X001) in the Network and Sharing Center.

Device Manager

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

- Intel(R) 82574L Gigabit Network Connection #2 corresponds to the Ethernet interface X000.
- Intel(R) 82574L Gigabit Network Connection corresponds to the Ethernet interface X001.



Fig. 30: Windows 10, identification of the Ethernet interfaces (X000, X001) in the device manager.

7.4 Beckhoff Device Manager

7.4.1 Starting the Beckhoff Device Manager

Using the Beckhoff Device Manager, an Industrial PC can be configured by remote access with the aid of a web browser. Depending on the image version, access takes place via different protocols and requires different open ports. For older image versions access takes place via the HTTP protocol and Port 80 (TCP). More up-to-date image versions use HTTPS and Port 443 (TCP).

Requirements:

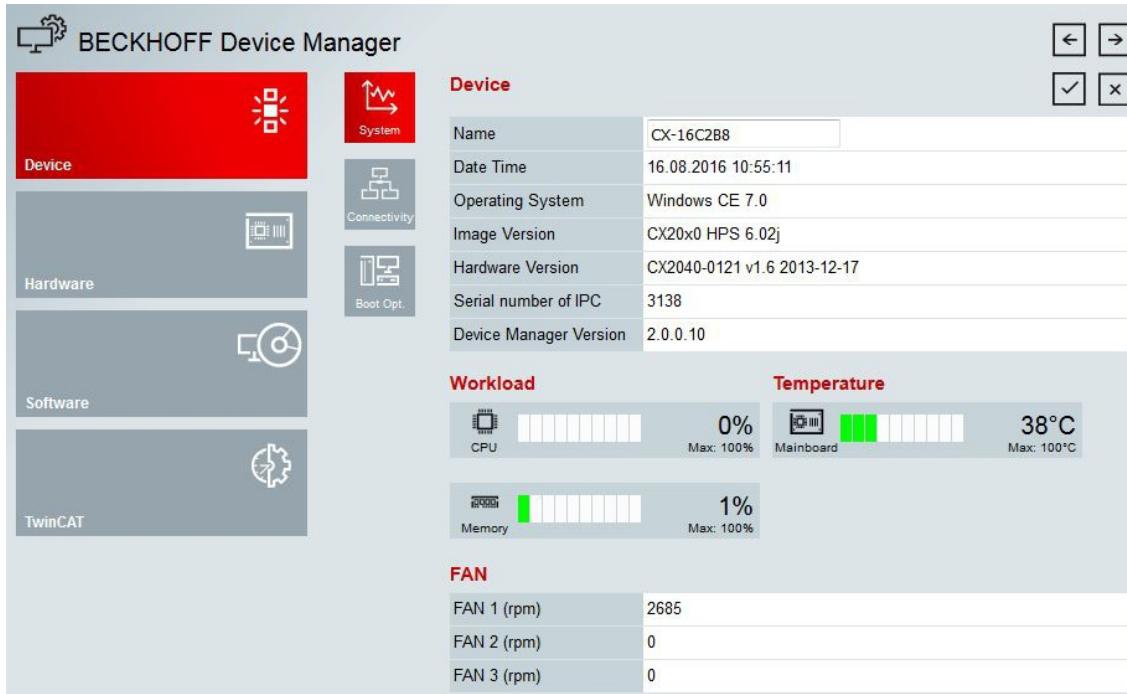
- Host PC and Embedded PC must be located in the same network. Depending on the operating system version, the network firewall must allow access via port 80 (HTTP) or port 443 (HTTPS).
- IP address or host name of the Embedded PC.

Table 29: Access data for the Beckhoff Device Manager on delivery.

User name	Password
Administrator	1

Start the Beckhoff Device Manager as follows:

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



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

7.4.2 Enabling a remote display

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

Requirements:

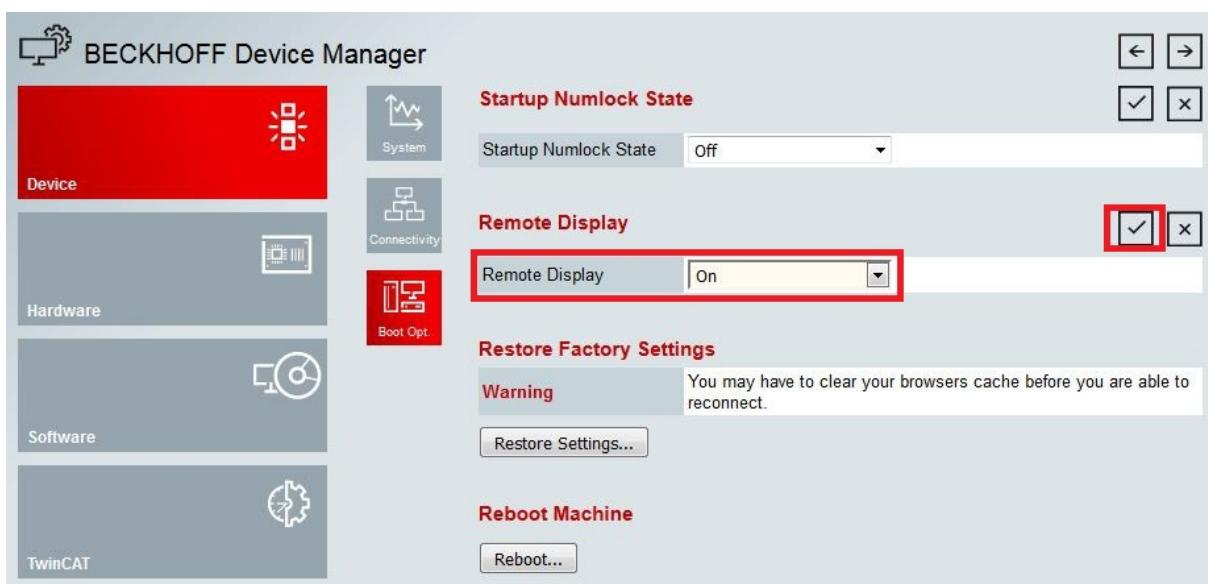
- Host PC and Embedded PC must be located in the same network. Depending on the operating system version, the network firewall must allow access via port 80 (HTTP) or port 443 (HTTPS).
- The IP address or the host name of the Embedded PC must be known.

Table 30: Access data for the Beckhoff Device Manager on delivery.

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

Enable the remote display as follows:

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



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

7.4.3 Starting a remote connection

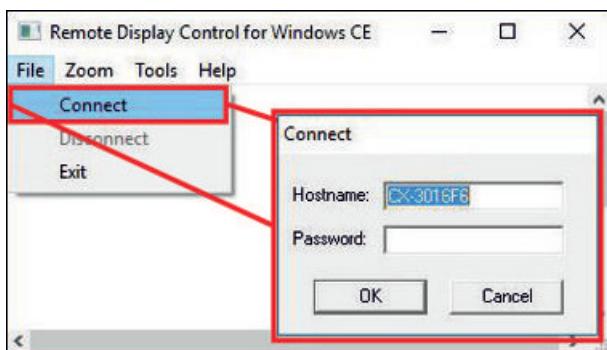
With the aid of the Remote Display Control program (CERHOST), a remote connection can be established and an Industrial PC with CE operating system can be remotely controlled from a host PC.

Requirements:

- Remote Display is active. See: Enabling a remote display.
- Host name of the Embedded PC.
- Remote Display Control (CERHOST). Download under: https://infosys.beckhoff.com/content/1033/CX2000_HW/Resources/5047075211/.zip

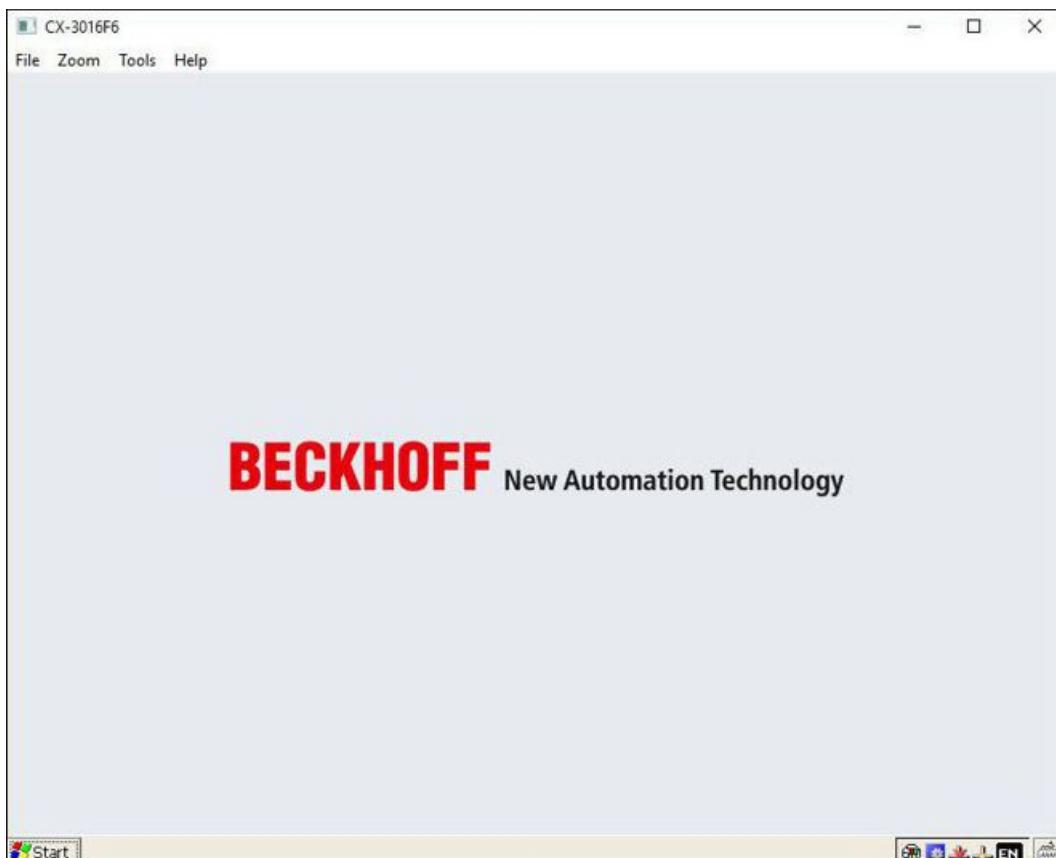
Start the remote connection as follows:

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



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

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



7.5 TwinCAT

7.5.1 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:

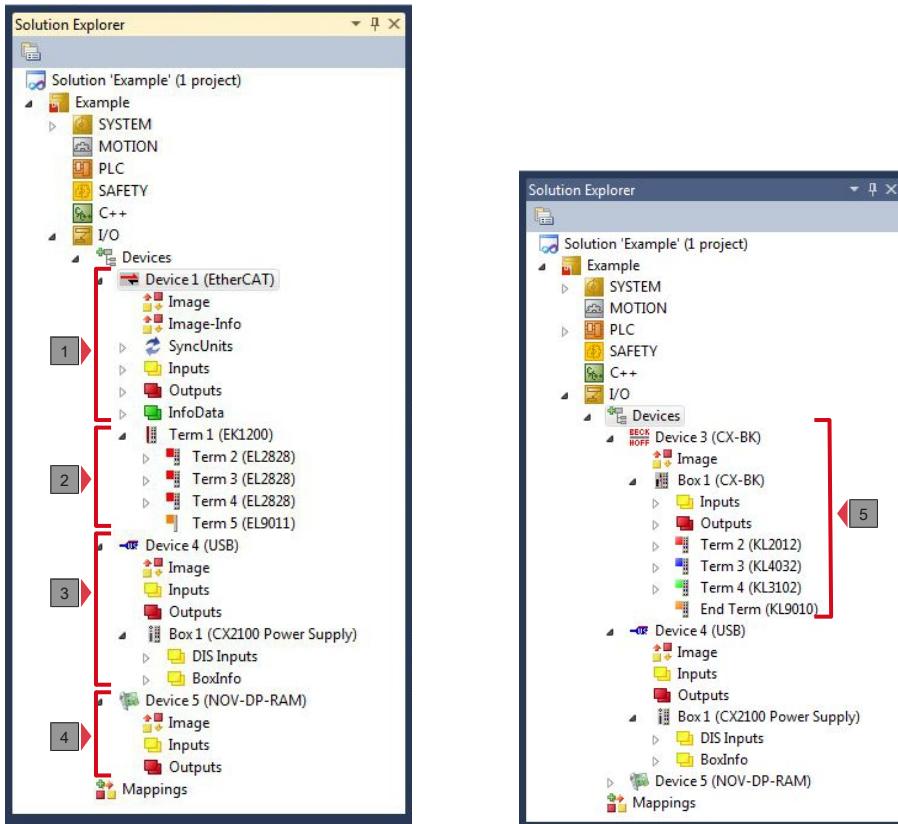


Fig. 31: CX20x0 Embedded PC in the tree view of TwinCAT 3, with attached EtherCAT Terminals (left) or Bus Terminals (right).

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

Table 31: 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 NOVRAM for storing up to 128 kB of data securely. At this point the NOVRAM 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.

7.5.2 Searching for target systems

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

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

Prerequisites for this step:

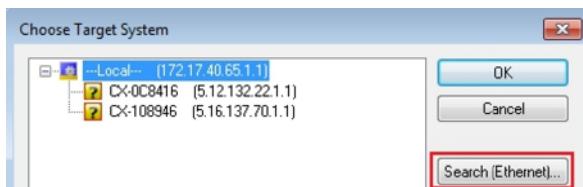
- TwinCAT 3 must be in Config mode.
- IP address or host name of the device.

Search for the devices as follows:

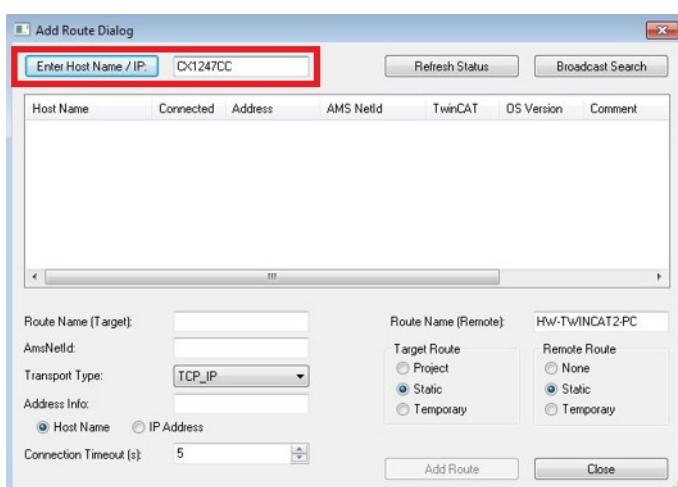
1. In the menu at the top click on **File > New > Project** and create a new TwinCAT XAE project.
2. In the tree view on the left click on **SYSTEM**, and then **Choose Target**.



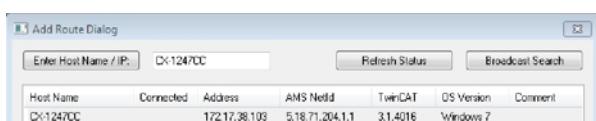
3. Click on **Search (Ethernet)**.



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

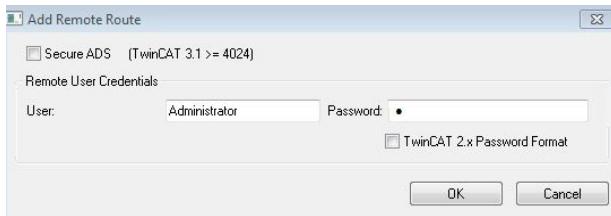


5. Mark the device found and click on **Add Route**.



The Logon Information window appears.

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

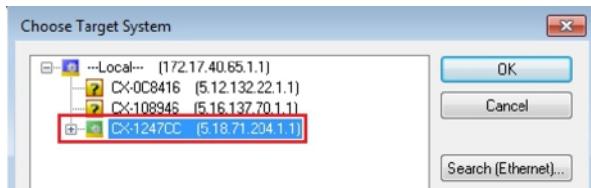


The following information is set as standard in CX devices:

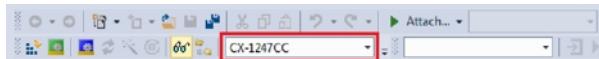
User name: Administrator **Password:** 1

6. If you do not wish to search for any further devices, click on **Close** to close the Add Route Dialog.
The new device is displayed in the Choose Target System window.

7. Select the device you want to specify as target system and click **OK**.



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



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

7.5.3 Scanning an Embedded PC

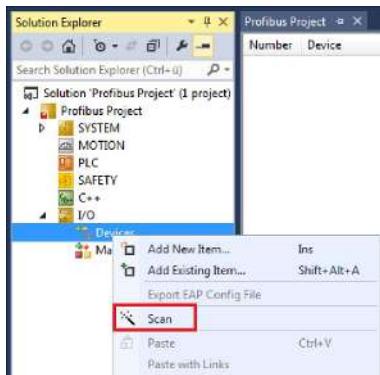
This step shows how to scan an Embedded PC in TwinCAT and then further configure it.

Prerequisites for this step:

- Selected target device.

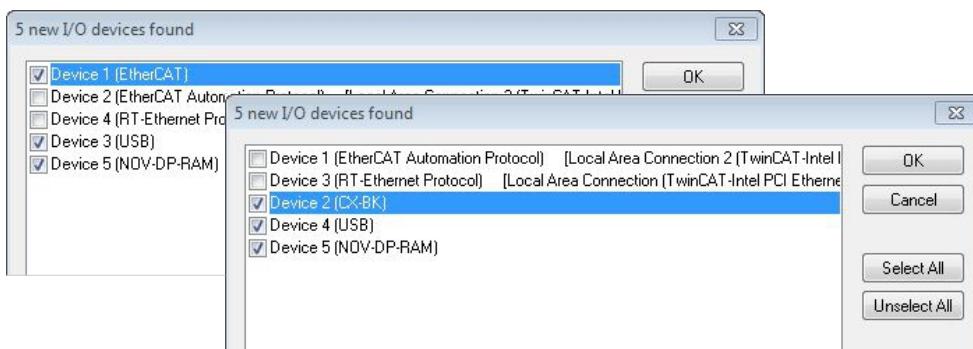
Add the Embedded PC as follows:

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



- 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.

- Confirm the request with **Yes**, in order to look for boxes.

- Confirm the request whether to enable FreeRun with **Yes**.

⇒ The Embedded PC was successfully scanned in TwinCAT and is displayed in the tree view with the inputs and outputs.

The Tree view chapter illustrates how Embedded PCs with connected Bus or EtherCAT Terminals are displayed.

7.5.4 Configuring EtherCAT cable redundancy.

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

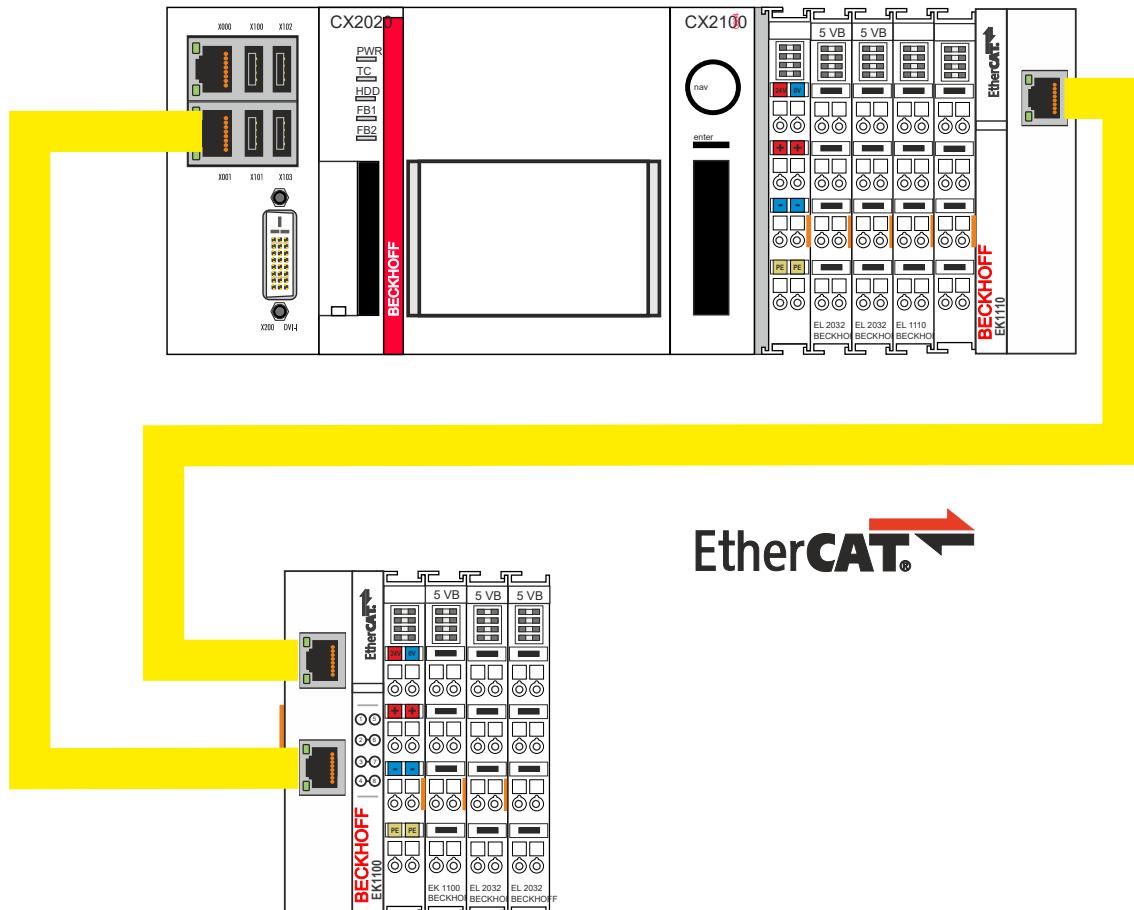


Fig. 32: Smallest possible configuration for EtherCAT cable redundancy.

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

Table 32: Cable redundancy, hardware for sample configuration.

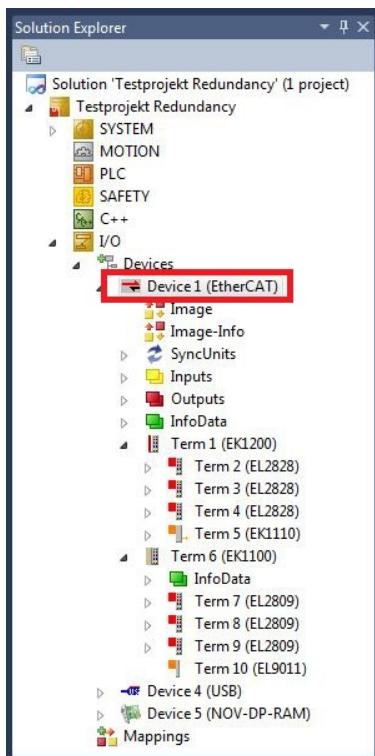
Type	Description
CX2020 Embedded PC	Is the EtherCAT master in the example.
Bus Coupler EK1110	EtherCAT extension can be used to extend an EtherCAT segment by up to 100 m.
EK1100 Bus Coupler	The Bus Coupler relays the EtherCAT signal to connected EtherCAT Terminals.
EtherCAT Terminals	Any number of EtherCAT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

Requirements:

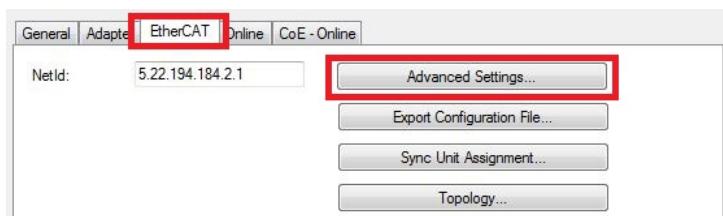
- For TwinCAT 2 you have to install and license the supplement TS622x | TwinCAT EtherCAT Redundancy on the Embedded PC:
<http://www.beckhoff.de/forms/twincat3/warenkorb.aspx?lg=de&title=TS622x-EtherCAT-Redundancy&version=1.0.2>
- In TwinCAT 3 the supplement is already included and only has to be licensed.
- 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.

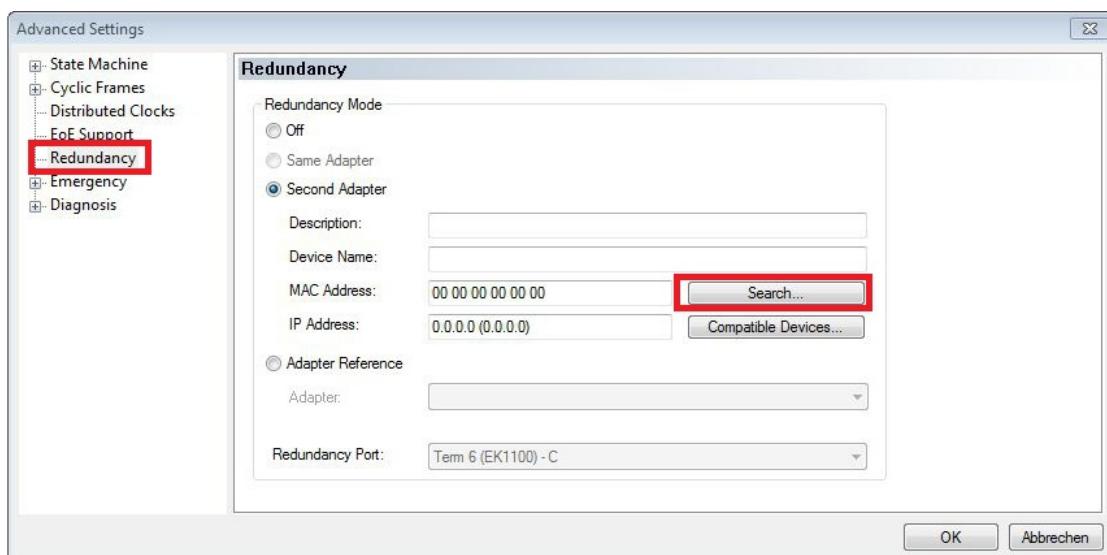


2. Click on the **EtherCAT** tab, then **Advanced Settings**.

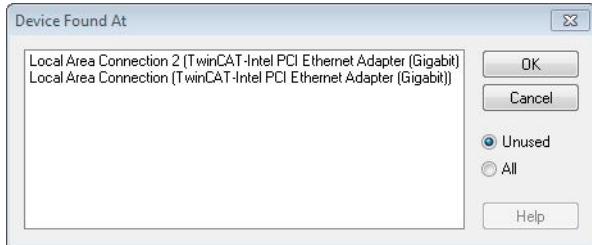


3. Click on **Redundancy** in the tree structure on the left.

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.

EtherCAT					
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.

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

7.5.5 Using a hardware watchdog

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

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

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

NOTE

Unwanted restart

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

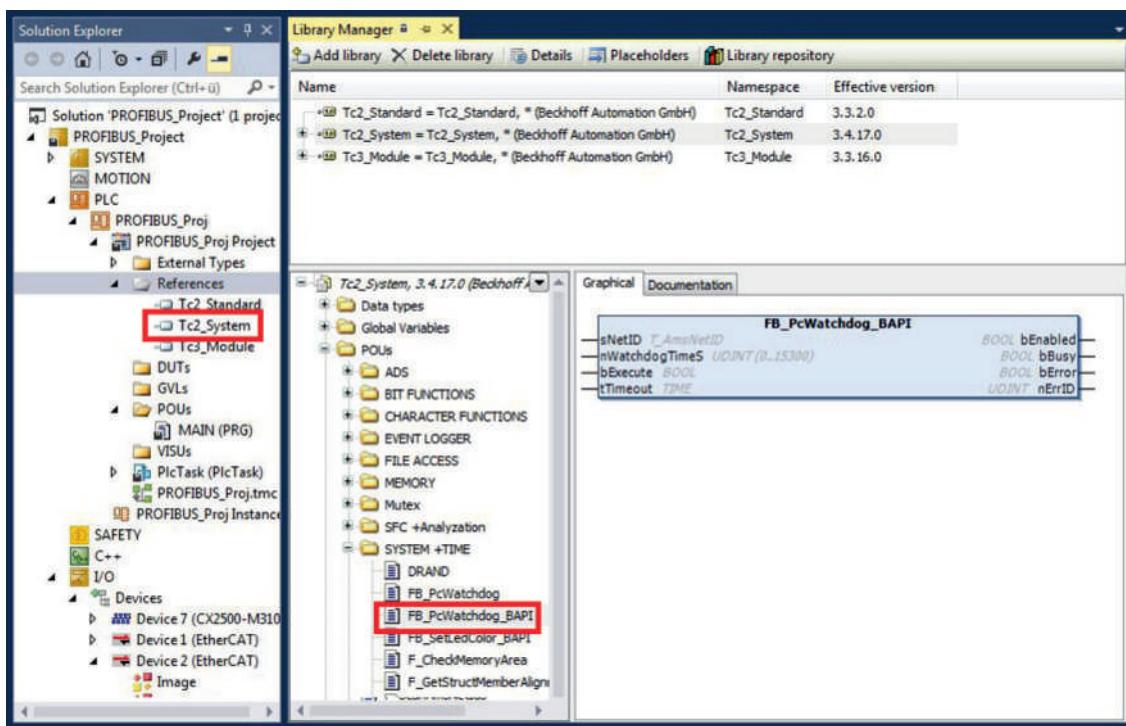
Be aware of this behavior and disable the watchdog if you use breakpoints, carry out a PLC reset or an overall reset, stop TwinCAT, switch to config mode or activate the configuration.

Requirements:

- Tc2_System library.
- TwinCAT v3.1.0
- A previously created PLC project in TwinCAT.

Locating the function block in TwinCAT:

1. Double-click on **Tc2_System** in the tree view under **PLC > PLC project > References**.
The Library Manager appears.



2. Under **Tc2_System > POU's > SYSTEM +TIME** click on the function block **FB_PcWatchdog_BAPI**.

⇒ The description of the function block can then be found under the **Documentation** tab or in the library description under: **FB_PcWatchDog_BAPI**. If necessary, you can install the **Tc2_System** library at a later stage via the **Add Library** button in the Library Manager.

8 NOVRAM

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

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

Functioning

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

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

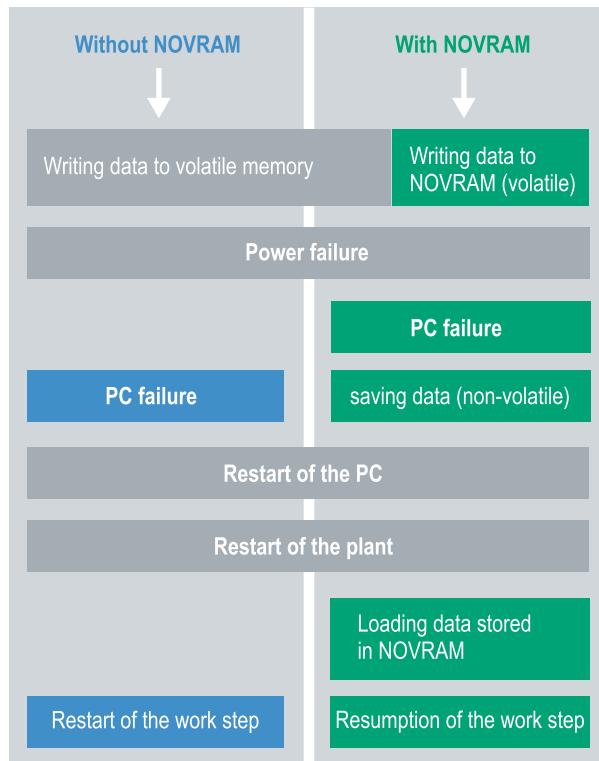


Fig. 33: Controller behavior with and without NOVRAM.

Memory size

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

Requirements

Development environment	Target platforms	Hardware	PLC libraries to include
TwinCAT 3.1 Build: 4020	PC or CX (x86, x64, ARM)	CX70xx, CX9020, CX20x0, CX20x2, CX20x3	Tc2_IoFunctions

8.1 Creating a Retain Handler

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.

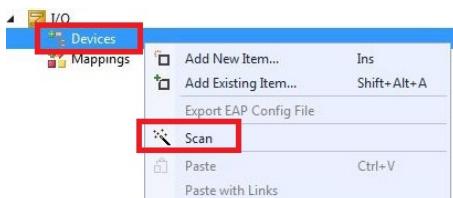
This chapter describes how to create a Retain Handler in TwinCAT 3. The Retain Handler saves data in the NOVRAM and makes them available again. In other words, important variable values such as production data or counter values are retained during a restart or power failure.

Requirements for this step:

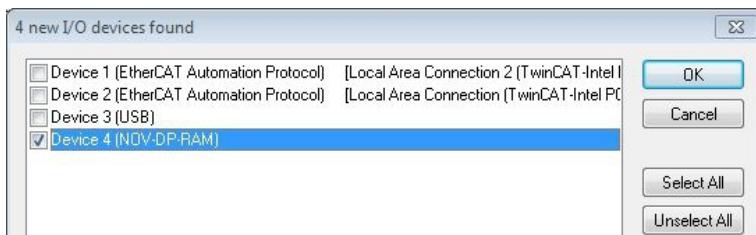
- TwinCAT 3.1 Build: 4020.
- A target device selected in TwinCAT.

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**.

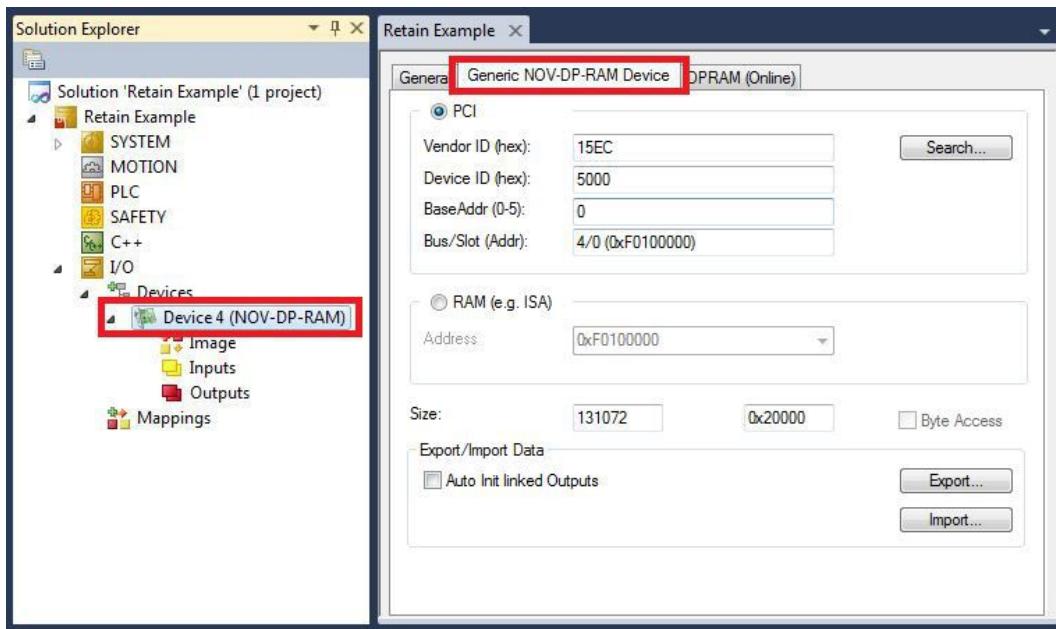


3. Select **Device (NOV-DP-RAM)** and confirm with **OK**.

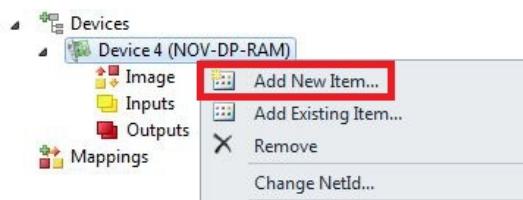


4. Click on **Yes** to search for boxes.

5. 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**.



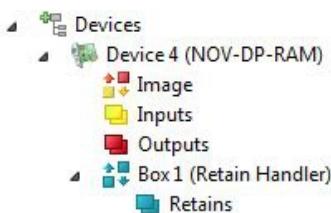
6. Click the option **PCI**.
 7. Right-click on **Device (NOV-DP-RAM)** in the tree view and then on **Add New Item**.



8. 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.

8.2 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.

```

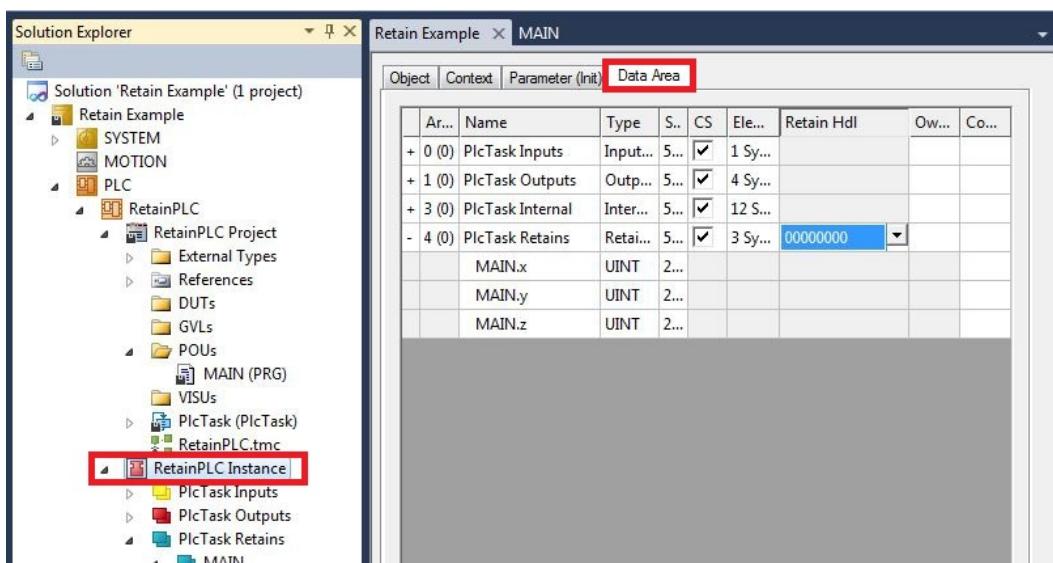
1 PROGRAM MAIN
2
3 VAR RETAIN
4     x      :UINT;
5     y      :UINT;
6     z      :UINT;
7 END_VAR
8
9 VAR
10
11     datain AT%I*: REAL;
12     dataout AT%Q*: BYTE;
13
14 END_VAR

```

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**.

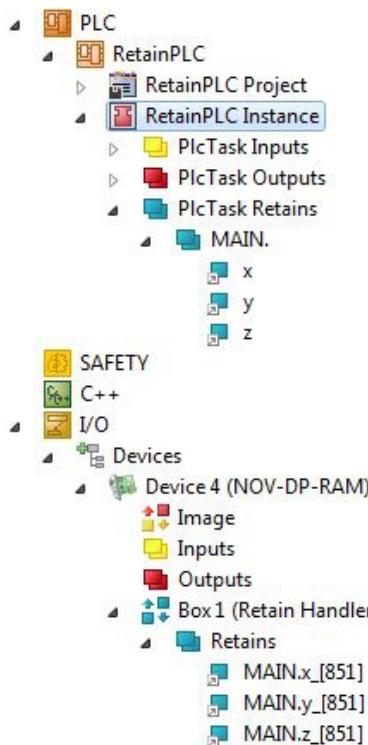


4. Under **Retain HdI**, select the Retain Handler that you have created.

MAIN								
Object		Context		Parameter (Init)		Data Area		
	Ar...	Name	Type	S..	CS	Ele...	Retain HdI	Ow...
+	0 (0)	PlcTask Inputs	Input...	5...	<input checked="" type="checkbox"/>	1 Sy...		
+	1 (0)	PlcTask Outputs	Output...	5...	<input checked="" type="checkbox"/>	4 Sy...		
+	3 (0)	PlcTask Internal	Inter...	5...	<input checked="" type="checkbox"/>	12 S...		
-	4 (0)	PlcTask Retains	Retain...	5...	<input checked="" type="checkbox"/>	3 Sy...	03020001 'Box1 (Retain Handler)'	
		MAIN.x	UINT	2...			00000000	
		MAIN.y	UINT	2...			03020001 'Box1 (Retain Handler)'	
		MAIN.z	UINT	2...				

⇒ 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.

8.3 Writing speed of the Retain Handler

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

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

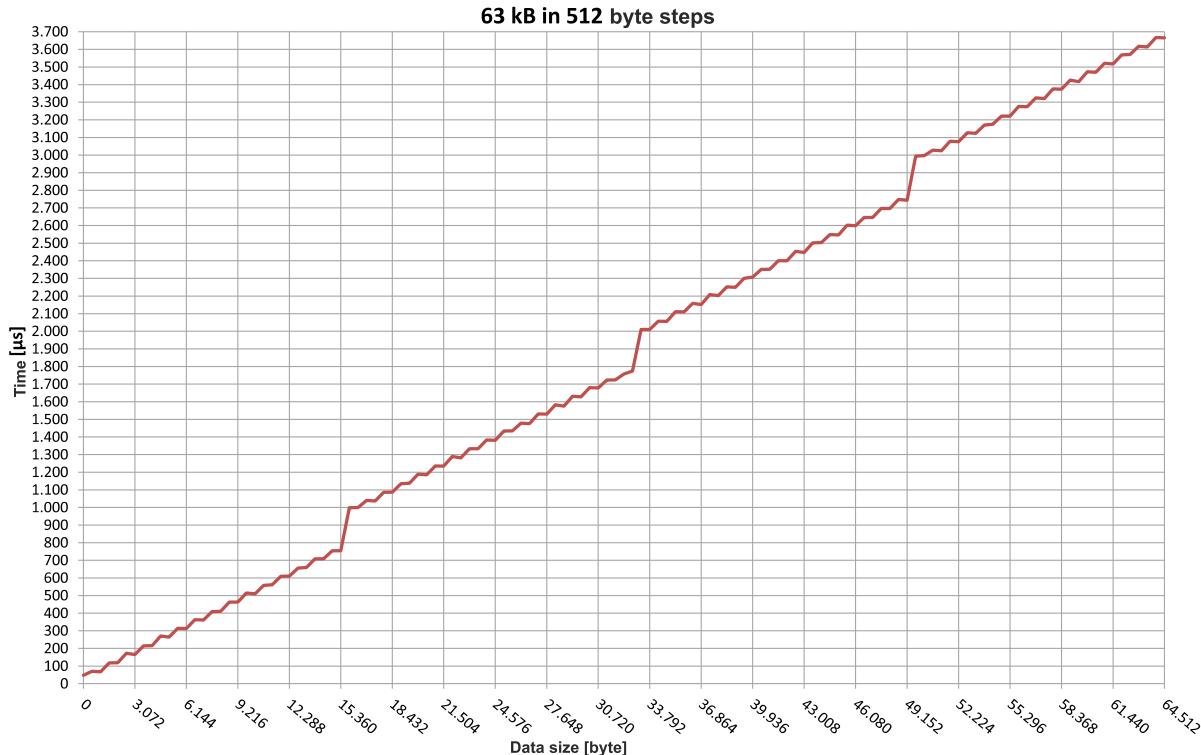


Fig. 34: Retain Handler write speed, up to 63 kB in 512 byte steps.

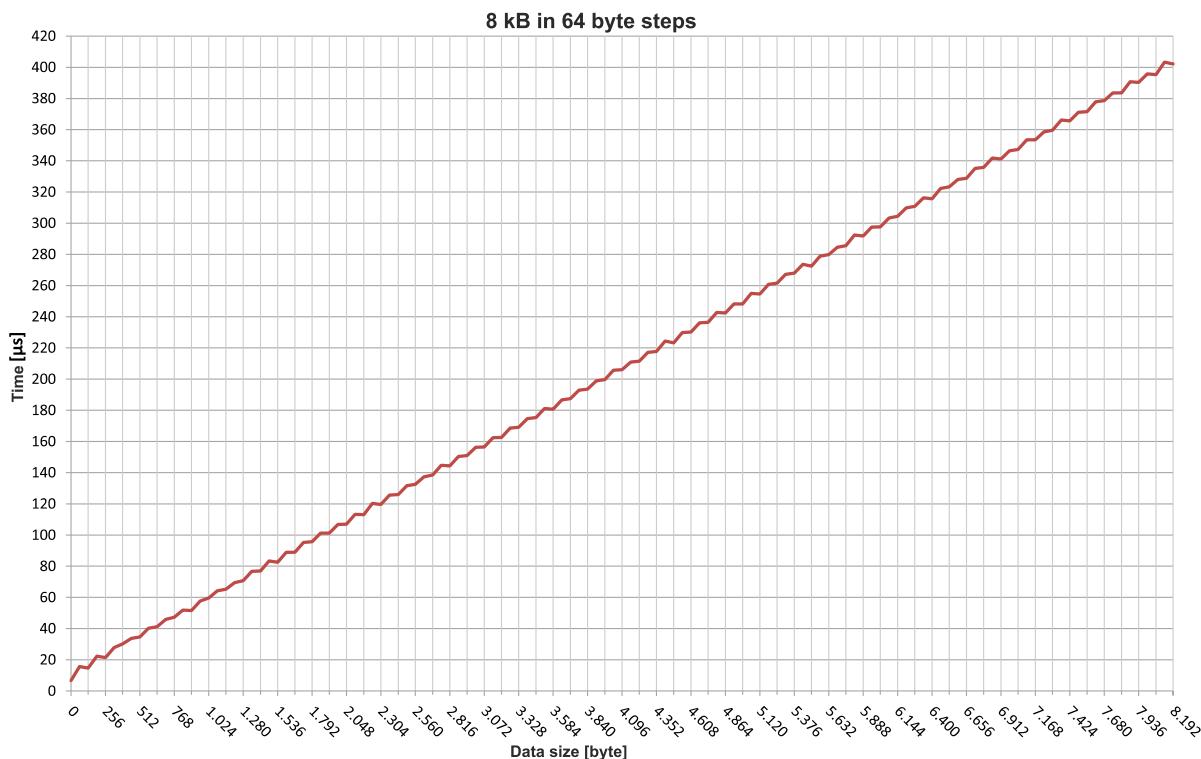


Fig. 35: Retain Handler write speed, up to 8 kB in 64 byte steps.

8.4 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.

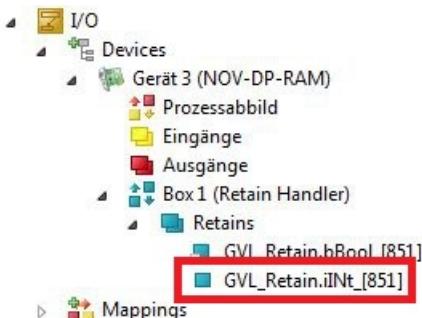
Under TwinCAT 3 the variables have to be deleted manually.

Prerequisites for this step:

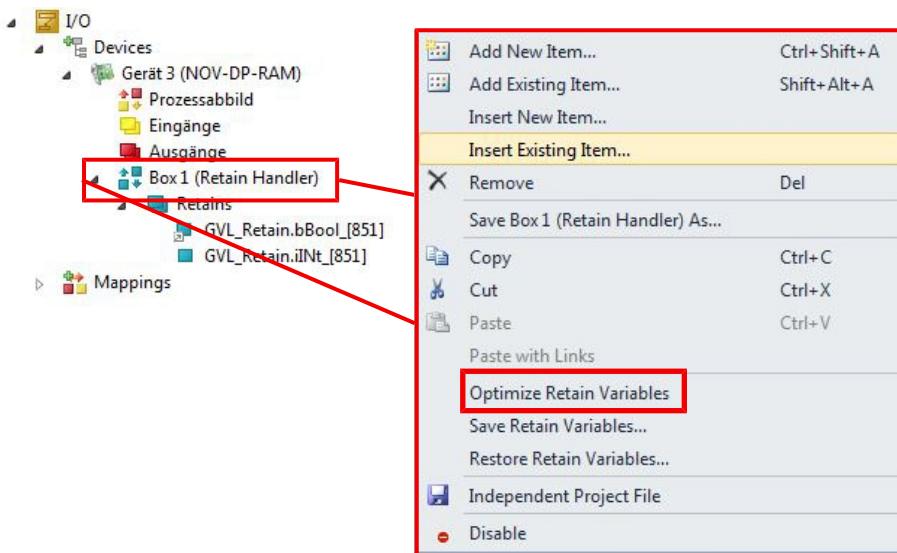
- Variables declared with VAR_RATAIN were deleted from the PLC.

Delete the variables under the Retain Handler as follows:

- The variable GVL_Retain.iNt under the Retain Handler is to be deleted.



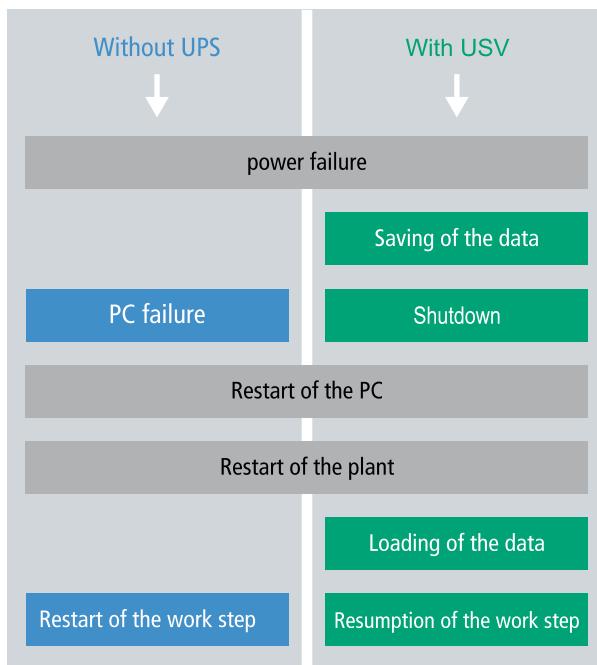
- Right-click on the **Retain Handler** in the tree view on the left.
- In the context menu click on **Optimize Retain Variables**.



⇒ The variable under the Retain Handler is deleted.

9 UPS (persistent data)

If the power supply fails, the UPS continues to supply the Embedded PC. During this period persistent data can be saved, which are available on switching on again. Use a UPS to shut down the Embedded PC in a controlled manner and to save persistent data.



The following UPS configurations can be used:

- CX2100-0904, power supply unit with integrated capacitive UPS.
- CX2100-0914 power supply unit and CX2900-0192 battery pack.

Storage location and names of the files:

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

Development environment	File path	File name
TwinCAT 2	C:\TwinCAT\Boot\	TCPLC_T_x.wbp TCPLC_T_x.wb~ (Backup) The x in the file name stands for the number of the runtime system.
TwinCAT 3	C:\TwinCAT\3.1\Boot\	Port_85x.bootdata Port_85x.bootdata-old (backup) The x in the file name stands for the number of the runtime system.

Configure the CX20x0 as follows in order to save persistent data:

- First of all you have to configure the UPS. Read how to do this in the relevant chapter of the CX2100-09x4 power supply documentation.
<https://download.beckhoff.com/download/document/ipc/embedded-pc/embedded-pc-cx/cx2100-09x4de.pdf>
- Configure the Windows write filter and issue the corresponding write permissions in order to be able to save persistent data (see: [Windows write filter \[► 71\]](#)).
- Declare important data such as counter values in the PLC as VAR PERSISTENT.
- Subsequently you can check the validity of the variables and monitor whether the persistent data are loaded without error (see: [Checking the validity of the variables \[► 71\]](#)).

Components	Version
TwinCAT on the development PC and on the control system	TwinCAT 2.11R3 Build 2047 (or higher) TwinCAT 3.1 Build 4018 (or higher)

9.1 Windows write filter

Since the persistent data are stored on a storage medium, the file and the path must be writeable. If you use the Windows write filter, the Windows partition is protected against write access operations, and the persistent data are not saved.

9.2 Checking the validity of the variables

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

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

9.2.1 PlcAppSystemInfo

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

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

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

    TComSrvPtr     : ITComObjectServer;

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

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

10 Error handling and diagnostics

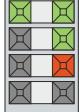
10.1 Diagnostic LEDs

Display	LED	Meaning
	PWR	Power supply The power LED lights green if the device is connected to a power supply unit and the unit is switched on. Die SUPS is active (violet).
	TC	TwinCAT status LED TwinCAT is in Run mode (green) TwinCAT is in Stop mode (red) TwinCAT is in Config mode (blue)
	HDD	Error or crash of the PLC (yellow). Applies only to TwinCAT 3
	FB1	Status LED1 for fieldbus (the function is described under the fieldbus interface)
	FB2	Status LED2 for fieldbus (the function is described under the fieldbus interface)

10.1.1 K-bus

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

Table 33: Diagnostic LEDs in K-Bus mode.

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

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

Table 34: K-bus ERR LED, fault indication sequence through the LED.

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

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 35: 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"> Check power supply for undervoltage or overvoltage peaks. Implement EMC measures. 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)
3 pulses	0	K-bus command error.	<ul style="list-style-type: none"> No Bus Terminal inserted. 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.
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.

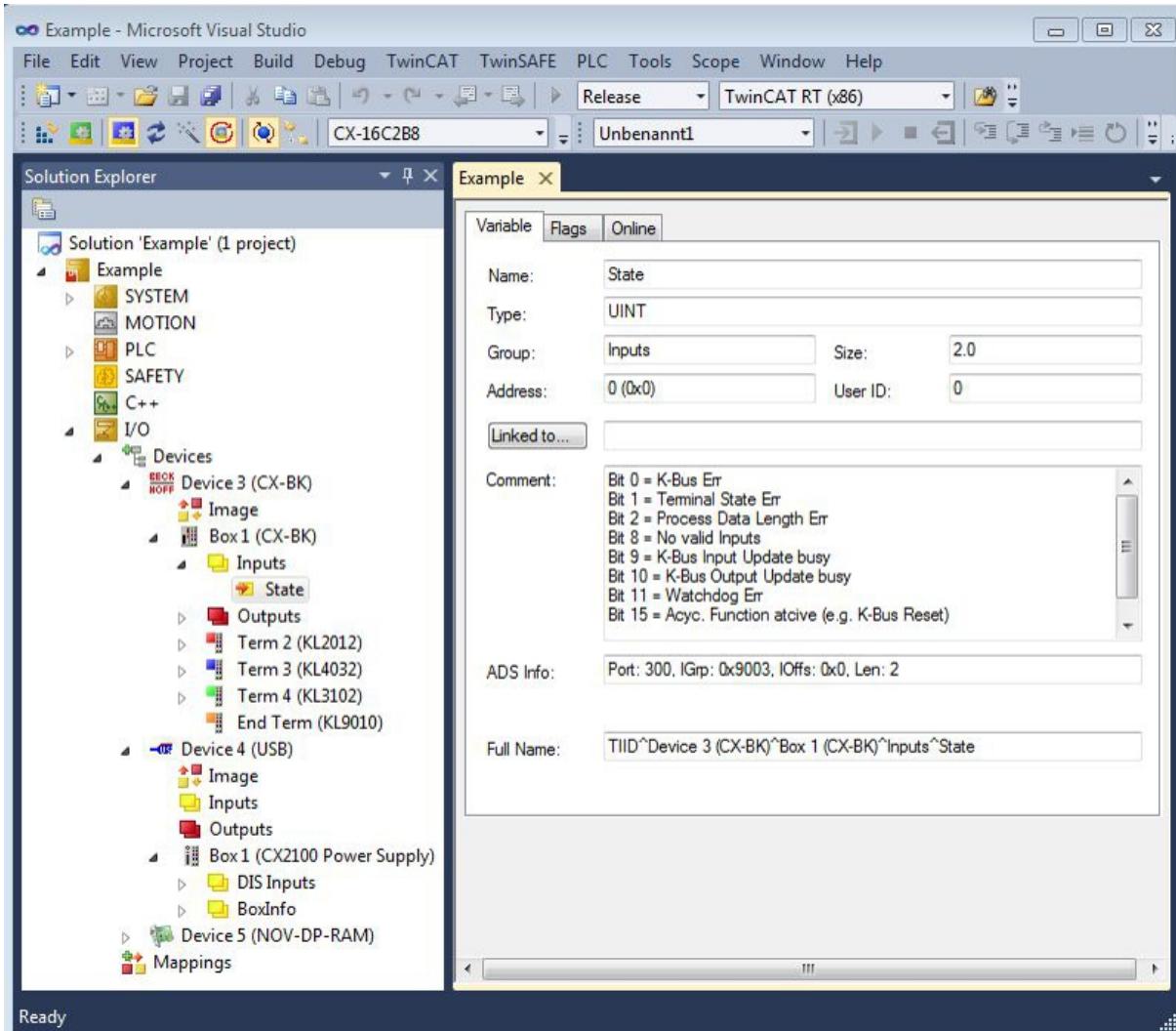


Fig. 36: Status variable for error handling and diagnostics under TwinCAT.

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 36: 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 TcloFunctions.lib).

10.1.2 E-bus

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

Table 37: Diagnostic LEDs in K-Bus mode.

Display	LED	Meaning
Us 24 V L/A	Up 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	E-bus not connected.
	off	E-bus connected / no data traffic.
	on	E-bus connected / data traffic on the E-bus.
	flashes	

10.2 Faults

Table 38: Possible faults and their correction.

Fault	Cause	Measures
No function after the Embedded PC has been switched on.	<ul style="list-style-type: none"> No power supply for the Embedded PC Other causes. 	<ol style="list-style-type: none"> Check the fuse. Check the supply voltage and the pin assignment. Call Beckhoff support.
Embedded PC does not boot fully.	Hard disk damaged (e.g. due to switching off while software is running), incorrect setup, other causes.	<ol style="list-style-type: none"> Check setup. Call Beckhoff support.
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"> Use another CFast card to test the card slot. Call Beckhoff support.
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	Replace the battery [▶ 78] .
Fan is not turning.	Fan faulty.	Replace the fan cartridge [▶ 78] .
CX20x0 with Windows Embedded Compact 7 does not find new hardware (e.g. extension modules).	The Embedded PC only searches for new hardware at the PCI bus on first startup.	Delete the folder "Documents and Settings" on the CFast card. See: Scan for new hardware [▶ 45]

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

- Precise device ID: CXxxxx-xxxx.
- Serial number.
- Hardware version.
- Any interfaces (N030, N031, B110, ...).
- TwinCAT version used.
- Any components / software used.

The quickest response will come from support / service in your country. Therefore please contact your regional contact. Check on our website at www.beckhoff.de or ask your distribution partner.

11 Care and maintenance

11.1 Replace the battery

NOTE

Risk of explosion

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

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

The battery must be replaced every 5 years. Spare batteries can be ordered from Beckhoff Service. A CR2032 battery (3 V, 225 mAh) is used in the Embedded PC.

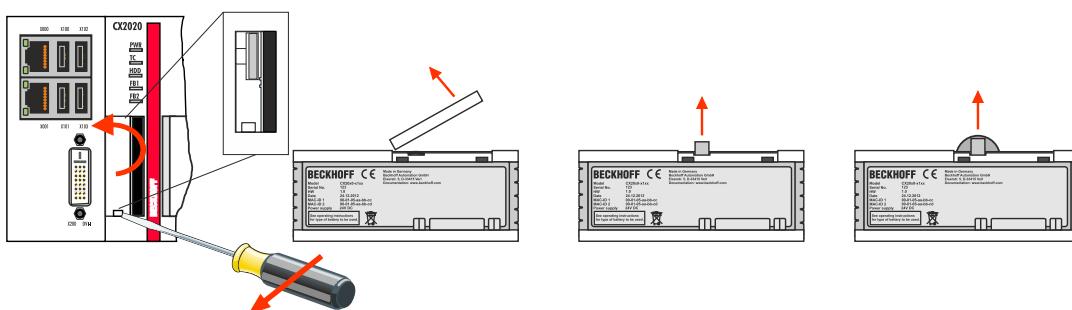
The battery compartment is below the front flap. The battery stores the time and date. The time and date are reset if the battery is removed. Be aware of this behavior for your hardware and software configuration and reset the time and date in the BIOS after a battery change. All other BIOS settings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

Requirements:

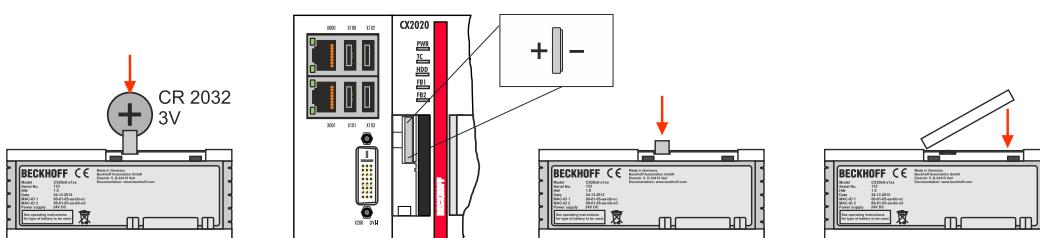
- The Embedded PC is switched off.

Replace the battery as follows:

1. 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.

11.2 Replace the fan cartridge



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 CX20x0 if:

- the fan cartridge has been used for 5 years

- or the fan speed is less than 1000 rpm.

In a CX20x0 Embedded PC the fan speed is controlled depending on the temperature.

Table 39: In the CX20x0 the fan control and speed depend on the temperature.

Temperature	Fan control	Fan speed
at 35 °C	0 %	1500 rpm
35 °C ... 61.25 °C	0% ... 100%, linear control	1500 rpm...5900 rpm, linear control
above 61.25 °C	100 %	5900 rpm

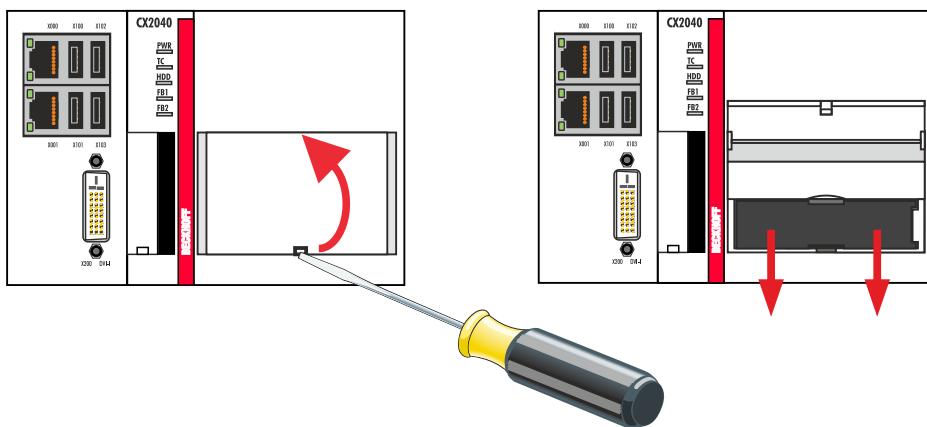
Use the IPC diagnostics and monitor the fan speed to determine a fan fault.

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

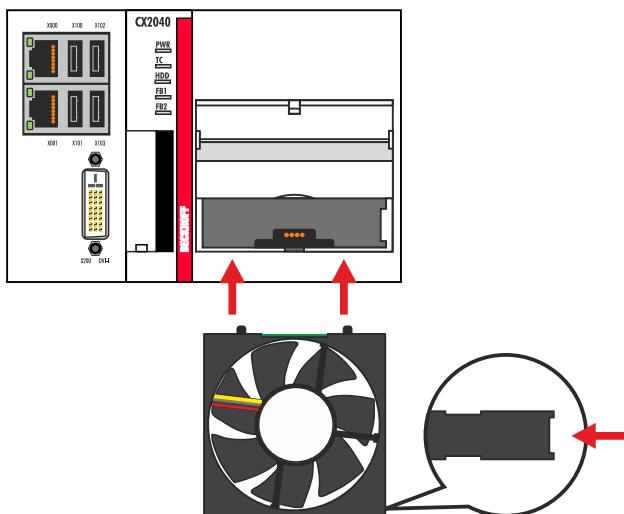
https://download.beckhoff.com/download/document/ipc/industrial-pc/ipc_diagnose_de.pdf

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.

12 Decommissioning

12.1 Removing cables

NOTE

Electrical voltage

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

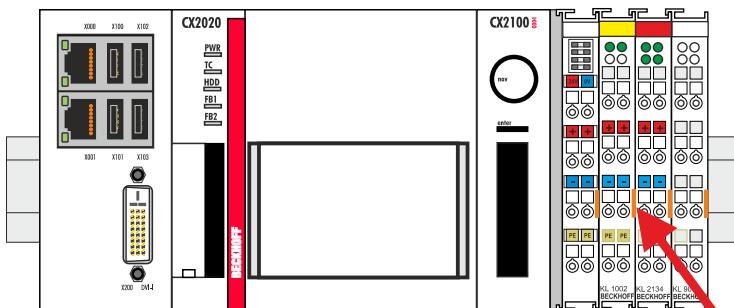
Before dismantling the Embedded PC, shut down the Embedded PC and switch off the power supply. Only then can you remove all the cables. Also remove all cables from the first terminal after the power supply terminal.

Requirements:

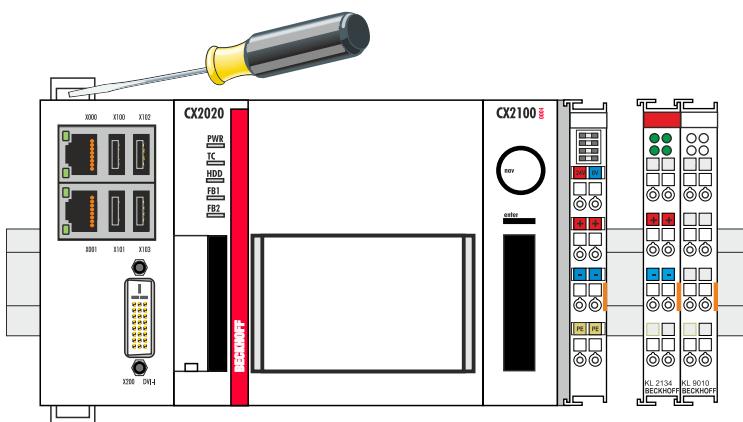
- Terminate your software and shut down the Embedded PC.
- Switch off the power supply.

Remove the cables as follows:

1. Remove the 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.



12.2 Dismantling the Embedded PC

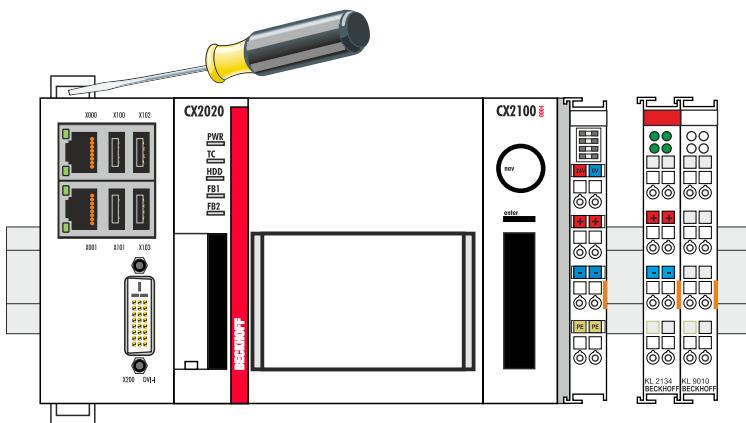
The CX2000 Embedded PC series is a modular system and enables individual modules to be replaced or removed quite easily. This section describes how to remove devices from the CX2000 Embedded PC series.

Requirements:

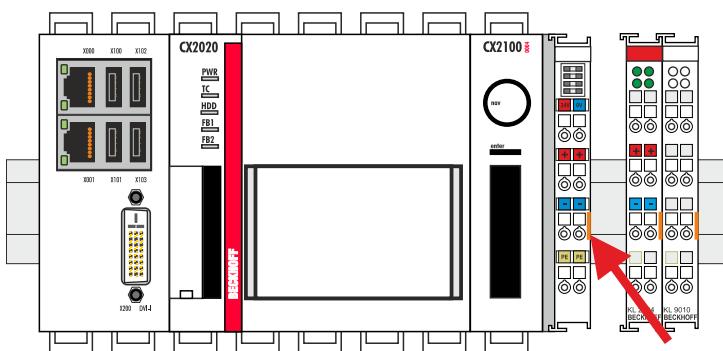
- All cables were removed from the Embedded PC.

Dismantle the Embedded PC as follows:

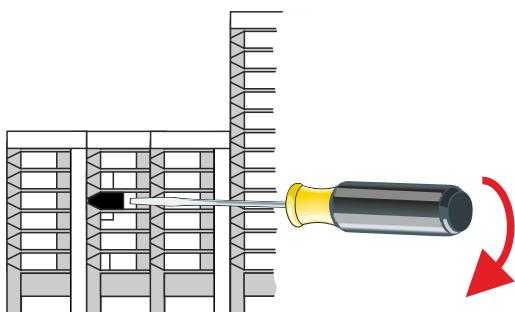
1. Release the DIN rail mounting by pushing the latches outwards with a screwdriver.

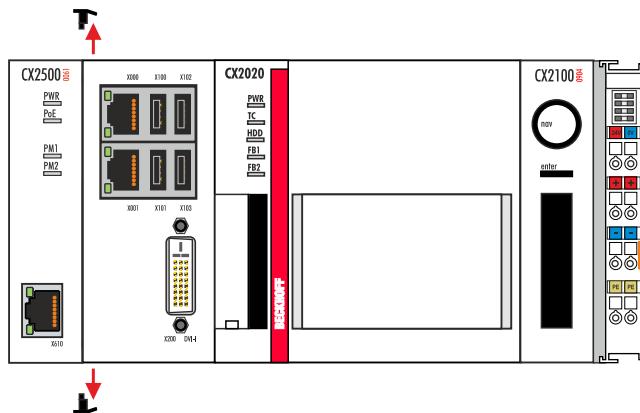


2. Pull the orange strap on the power supply unit and gently remove the device from the DIN rail.



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.

13 Technical data

Table 40: Technical data, dimensions and weights.

	CX2020	CX2030	CX2040
Dimensions (W x H x D)	144 mm x 99 mm x 91 mm		
Weight	approx. 1160 g	approx. 1165 g	approx. 1230 g

Table 41: Technical data, general data.

Technical data	CX2020	CX2030	CX2040
Processor	Intel® Celeron® 827E 1,4 GHz, single-core	Intel® Core™ i7 2610UE 1,5 GHz, dual-core	Intel® Core™ i7 2715QE 2,1 GHz, quad-core
Main memory	2 GB DDR3-RAM	2 GB DDR3-RAM	4 GB DDR3-RAM
Flash memory	20 GB or 40 GB, CFast card with extended temperature range (optionally extendable)		
NOVRAM integrated		128 kB	
Power supply		24 V DC (-15 %/+20 %)	
max. power consumption	21 W	27 W	32 W
Dielectric strength	500 V (supply / internal electronics)		
Operating system	Microsoft Windows Embedded Compact 7 Microsoft Windows Embedded Standard 7 P Microsoft Windows 10 IoT Enterprise LTSB		
Control software	TwinCAT-2-PLC-Runtime, -NC-PTP-Runtime, -NC-I-Runtime 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, UL		

Table 42: 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. 2A
Current load of the power contacts	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 43: Technical data, environmental conditions.

Technical data	Description
Ambient temperature during operation	-25 °C to +60 °C
Ambient temperature during storage	-40 °C to +85 °C See notes under: Transport and storage [▶ 13]
Relative humidity	95% without condensation
Vibration resistance	10 frequency sweeps in 3 axes 10 Hz < f < 58.1 Hz displacement 0.15 mm, constant amplitude 58.1 Hz < f < 500 Hz acceleration 2 g (~ 20 m/s ²), constant amplitude conforms to EN 60068-2-6
Shock resistance	1000 shocks in each direction, in 3 axes 15 g, 11 ms 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 44: Technical data, graphic specifications.

Technical data	CX2020	CX2030	CX2040
Processor graphics	Intel® HD Graphics	Intel® HD Graphics 3000	Intel® HD Graphics 3000
Graphic memory	128 MB (Shared Memory)		
Base clock frequency	350 MHz	350 MHz	650 MHz
Max. dynamic graphic frequency	800 MHz	850 MHz	1.2 GHz
Shader Model	4.1		
DirectX	10.1		
OpenGL	3.1		

Table 45: Technical data, interfaces.

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

Table 46: 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-pin Electrical isolation 500 V
RS422/RS485	D-Sub plug, 9-pin Electrical isolation 500 V
EtherCAT slave	2 x RJ 45, EtherCAT IN and OUT 100 MBaud
PROFIBUS	D-Sub plug, 9-pin 9,6 kbaud to 12 Mbaud
CANopen	D-Sub plug, 9-pin 10 kbaud to 1,000 kbaud
PROFINET RT	2 x RJ-45 switches

14 Appendix

14.1 Accessories

Table 47: CFast cards

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

Table 48: HDD/SSD

Order number	Description
CX2900-0401	Hard disk, SATA, 2½-inch, 1 TB
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
CX2900-0505	Solid-state disk SSD, SATA, 3D flash, 2½-inch, 960 GB

larger capacities on request

Table 49: Passive DVI-to-VGA adapter.

Order number	Description
CX1900-0101	Passive DVI-to-VGA adapter 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 50: Spare battery for CX systems.

Order number	Description
CX1900-0102	Replacement battery, suitable for CX10x0, CX50x0, CX51x0, CX52x0, CX90x0, CX20xx and CX8100 – Lithium button cell type CR2032, 3 V/225 mAh

Table 51: Further spare parts.

Order number	Description
CX2900-0101	Housing locking clips (black) for CX20xx and CX52x0 series. 10 locking sets of two clips each.
CX2900-0102	Cover for left-side bus connector, 5 pieces
CX2900-0103	Replacement fan cartridge for CX2040, CX2042, CX2062, CX2072 and CX2020, CX2030 with fan option. – Tray 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): 66 x 67 x 16 mm
CX2900-0104	Connector set (spare part) for connecting CX2100-0914 UPS module and CX2900-0192 battery pack
CX2900-0105	Replacement hood for CX2550-0020 2½-inch SSD/HDD module
CX2900-0106	Replacement frame for CX2550-0020 2½-inch SSD/HDD module

14.2 Certifications

FCC Approvals for the United States of America

FCC: Federal Communications Commission Radio Frequency Interference Statement

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

FCC Approval for Canada

FCC: Canadian Notice

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

14.3 Support and Service

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- spare parts service
- hotline service

Hotline: +49 5246 963 460
Fax: +49 5246 963 479
e-mail: service@beckhoff.com

Beckhoff Headquarters

Beckhoff Automation GmbH & Co. KG

Huelshorstweg 20
33415 Verl
Germany

Phone: +49 5246 963 0
Fax: +49 5246 963 198
e-mail: info@beckhoff.com
web: <https://www.beckhoff.com>

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More Information:
www.beckhoff.com/CX2000

Beckhoff Automation GmbH & Co. KG
Hülsorstweg 20
33415 Verl
Germany
Phone: +49 5246 9630
info@beckhoff.com
www.beckhoff.com

