BECKHOFF New Automation Technology

Manual | EN

CX2100-0904

Power supply unit with integrated capacitive UPS



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1 Notes on the documentation

This description is intended exclusively for trained specialists in control and automation technology who are familiar with the applicable national standards.
For installation and commissioning of the components, it is absolutely necessary to comply with the documentation and the following notes and explanations.
The qualified personnel is always obliged to use the currently valid documentation.

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

Disclaimer

The documentation has been prepared with care. The products described are, however, constantly under development.
We reserve the right to revise and change the documentation at any time and without notice.
No claims to modify products that have already been supplied may be made on the basis of the data, diagrams, and descriptions in this documentation.

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Patents

The EtherCAT Technology is covered by the following patent applications and patents, without this constituting an exhaustive list:
EP1590927, EP1789857, EP1456722, EP2137893, DE102015105702
and similar applications and registrations in several other countries.

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1.1 Representation and structure of warnings

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

Warnings relating to personal injury:

⚠ DANGER
Hazard with high risk of death or serious injury.

⚠ WARNING
Hazard with medium risk of death or serious injury.

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

Warnings relating to damage to property or the environment:

NOTICE
There is a potential hazard to the environment and equipment.

Notes showing further information or tips:



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

1.2 Related documents

This documentation contains and describes material that is relevant for the CX2100-0904 power supply unit. The CX2100-0904 power supply unit 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
CX20x0 multi-core

Retaining the documentation

This documentation is part of the CX2100-0904 power supply unit. Keep the documentation in the immediate vicinity of the device throughout its entire service life. Ensure that personnel have access to the documentation at all times. Pass on the documentation to subsequent users, and in addition ensure that all supplementary information is included in the documentation.

1.3 Documentation issue status

Version	Modifications
1.0	First version
1.1	Chapter "Display" revised
1.2	Chapter "Mounting passive EtherCAT Terminals" updated.
1.3	Chapter "Commissioning" updated.
1.4	Editorial corrections

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 CX2100-0904 power supply unit is part of 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 CX2100-0904 power supply unit supplies power to the Embedded PCs of the CX2000 series, the system modules and the extension modules. The Embedded PCs of the CX2000 series are then used together with bus terminals to receive digital and analog signals from sensors and output them to actuators or forward them to higher-level controllers.

The CX2100-0904 power supply units are 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 power supply unit is not suitable for operation in the following areas:

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

2.2 Staff qualification

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

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

2.3 Safety instructions

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

Mounting

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

Working with networks

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

3 Transport and storage

Transport

NOTICE

Short circuit due to moisture

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

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

Despite the robust design of the unit, the components are sensitive to strong vibrations and impacts. During transport, protect the power supply unit against:

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

Table 1: Dimensions and weights.

Technical data	CX2100-0904
Dimensions (W x H x D)	118 mm x 100 mm x 91 mm
Weight	1025 g

Storage

- Store the power supply unit in a dry environment at an ambient temperature between -25° C ... +60° C.
- Store the power supply unit in its original packaging.

4 Product overview

The CX2100-0904 power supply unit supplies power to CX2000 series Embedded PCs. The power supply unit is suitable for CX2020 and CX2030 Embedded PCs. Additional components such as system, expansion and fieldbus modules are also provided.

A special feature of the CX2100-0904 power supply unit is its integrated capacitive UPS. In the event of a power failure this enables the system to save data on the storage medium and then shut down in an orderly manner.

Display

The power supply unit CX2100-0904 has an FSTN LCD display with 2 x 16 characters, a selector switch and an Enter key. This allows internal status values as well as custom display parameters or menus, with and without input options, to be queried. The power supply units are controlled via TwinCAT.

Power supply terminal

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

Further power supply units

A total of four different power supply units are available for the Embedded PCs of the CX2000 series:

- 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 external battery packs in order to maintain UPS functionality.

Whether a power supply unit can be used together with a specific Embedded PC of the CX2000 series depends on the embedded PC used, the installation position and whether the embedded PC has active cooling.

Table 2: Other power supply units and compatible Embedded PCs from the CX2000 series.

Embedded PC	CX2100-0004	CX2100-0014	CX2100-0904	CX2100-0914
CX2020	X	X	X	X
CX2030	X	X	X	X
CX2040	-	X	-	X
CX2020 (with fan)	-	X	-	X
CX2030 (with fan)	-	X	-	X
CX2042	-	X	-	X
CX2062	-	X	-	-
CX2072	-	X	-	-
CX2033	X*	X	X*	X
CX2043	-	X	-	X
CX2033 (with fan)		X		X

* Can be used if the total load does not exceed 45 W, e.g. due to USB devices or CX25xx modules.

4.1 Configuration of the CX2100-0904 power supply unit

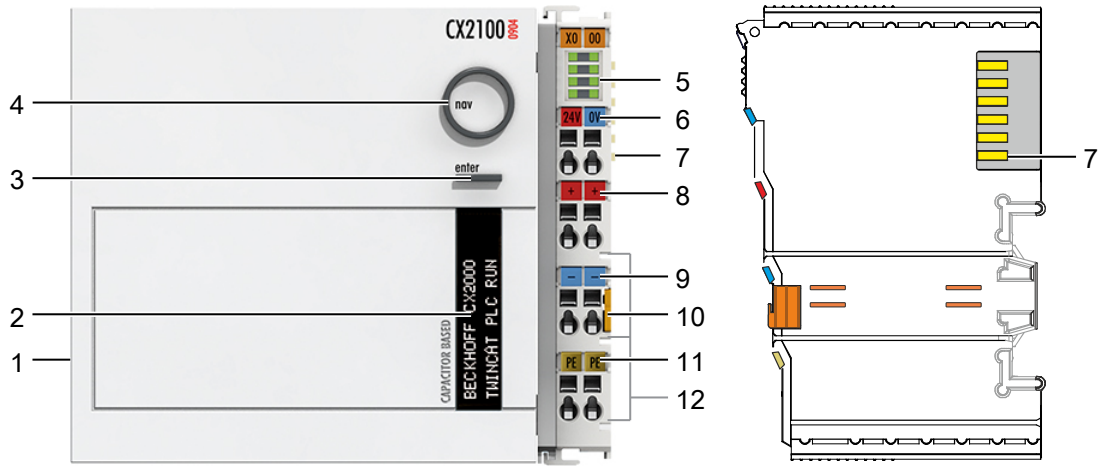


Fig. 1: Configuration of the CX2100-0904 power supply unit.

Table 3: Legend for the configuration.

No.	Component	Description
1	Multi-pole connection	For connection to the basic CPU module on the right.
2	FSTN LCD display [▶ 22]	Backlit display with 2 x 16 characters.
3	Enter key [▶ 33]	Allows input and query of internal status values.
4	Selector switch [▶ 33]	For navigation in menus.
5	Diagnostic LEDs [▶ 74], power supply terminal.	Diagnosis of the power supply for the Embedded PC and the terminal bus. Status of the E-bus and K-bus communication.
6	Spring-loaded terminals, +24 V and 0 V	Power supply for Embedded PC.
7	Terminal bus (K-bus or E-bus)	Interface for EtherCAT Terminals or Bus Terminals. Data exchange and supply.
8	Spring-loaded terminal, +24 V	Power supply for Bus Terminals via power contact.
9	Spring-loaded terminal, 0 V	Power supply for Bus Terminals via power contact.
10	Terminal release	Releases the power supply terminal and therefore the Embedded PC from the mounting rail.
11	Spring-loaded terminal, PE	Spring-loaded terminal for power contact PE.
12	Power contacts, +24 V, 0 V, PE	Power contacts for Bus Terminals.

4.2 Name plate

The CX2100-0904 power supply unit features a name plate on the left-hand side of the housing.

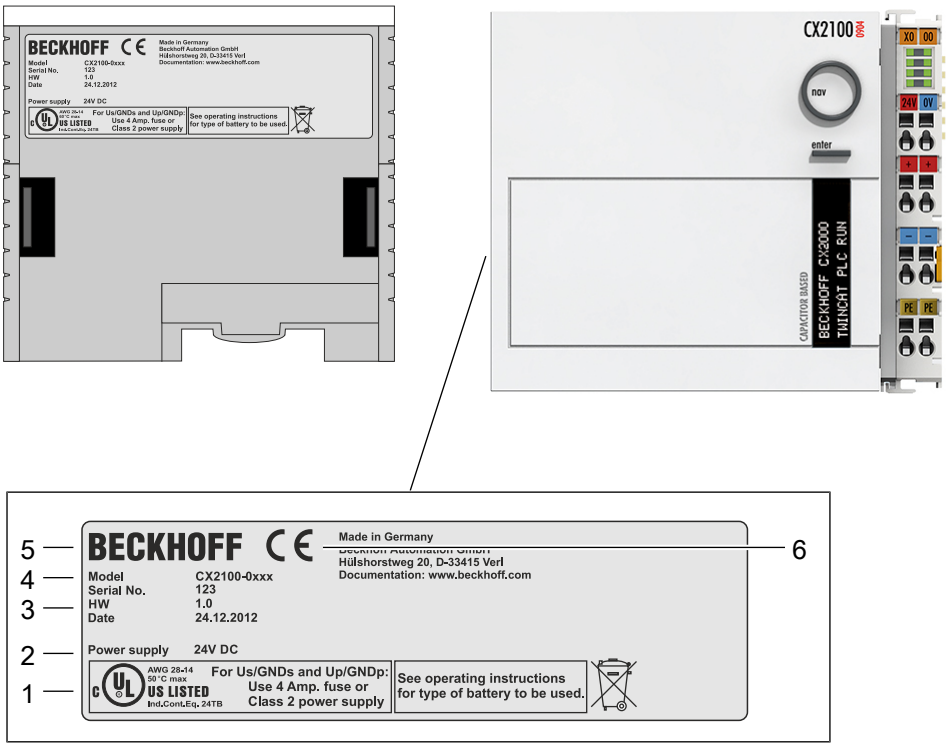


Fig. 2: CX2100-0904 power supply unit name plate.

Table 4: Legend for the name plate.

No.	Description
1	UL approval with prescribed information on power supply, fuse, temperature and cable cross-sections.
2	Information on the power supply unit.
3	Information on: • serial number, • hardware version • and date of manufacture.
4	Information on the model. The last four numerals relate to the configuration of the power supply unit.
5	Vendor data including address.
6	CE conformity.

5 Commissioning

5.1 Mounting

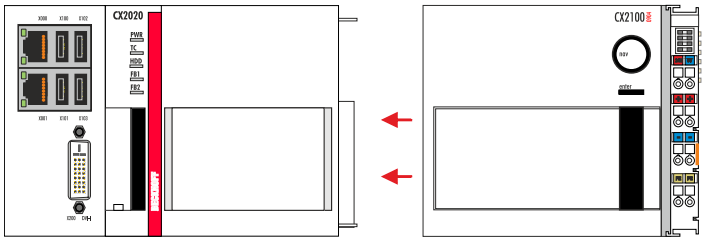
This chapter describes how to install the CX2100-0904 power supply unit. This documentation uses the CX2020 Embedded PC to demonstrate the procedure.

5.1.1 Attaching the power supply unit

The CX2100-0904 power supply unit supplies power to Embedded PCs of the CX2000 series. The power supply unit and the embedded PC are connected via the multi-pole connector.

Proceed as follows:

1. Plug the power supply unit into the high-pole connection on the right on the basic CPU module.



2. Check whether the power supply unit is flush with the embedded PC.

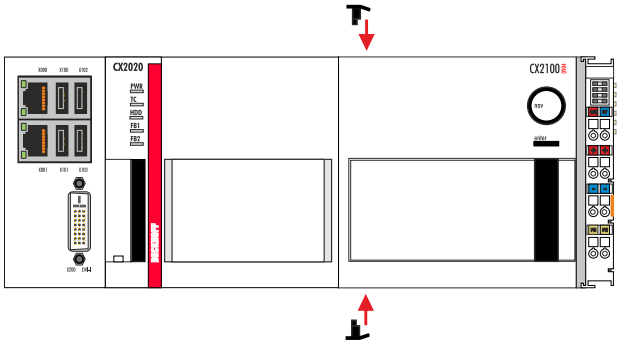
⇨ In the next step, you can install the bar clips.

5.1.2 Installing the bar clips

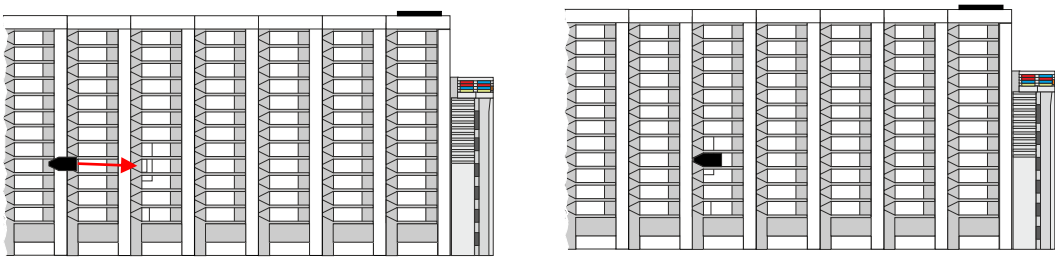
Usually, the connection between the modules is strong enough. However, the basic CPU module and the attached modules may be subjected to shocks, vibrations or other impacts. The modules can be securely connected to one another with the aid of bar clips.

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.



3. Check that the bar clips are flush.

⇨ The bar clips have been installed successfully, if they don't protrude and are flush with the cooling fins of your modules.
Once all modules are latched, the devices can be installed on the mounting rail.

5.1.3 Note the permissible installation positions

NOTICE

Increased heat generation

If the minimum distances are not observed, the power supply unit and the Embedded PC may overheat.

- Leave at least 30 mm clearance above and below the Embedded PC. Ensure adequate ventilation. Maintain the permissible ambient temperature in the vicinity of the power supply unit and Embedded PC.

Note the following specifications for the control cabinet:

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

The CX2100-0904 power supply unit and the embedded PC must be mounted horizontally on the mounting rail. The CX2100-0904 power supply unit does not support vertical or lying installation positions.

Table 5: Compatible Embedded PCs and permissible mounting positions.

	CX2020	CX2030
Horizontal installation position	x	x
Vertical installation position	-	-
Ambient temperature during operation	-25° C ... +50° C	-25° C ... +50° C

Horizontal installation position

Maintain the ambient temperatures. In addition, a minimum clearance of 30 mm above and below the cooling fins of the embedded PCs is required in order to ensure adequate ventilation. This ensures optimum air flow through the cooling fins of the embedded PC.

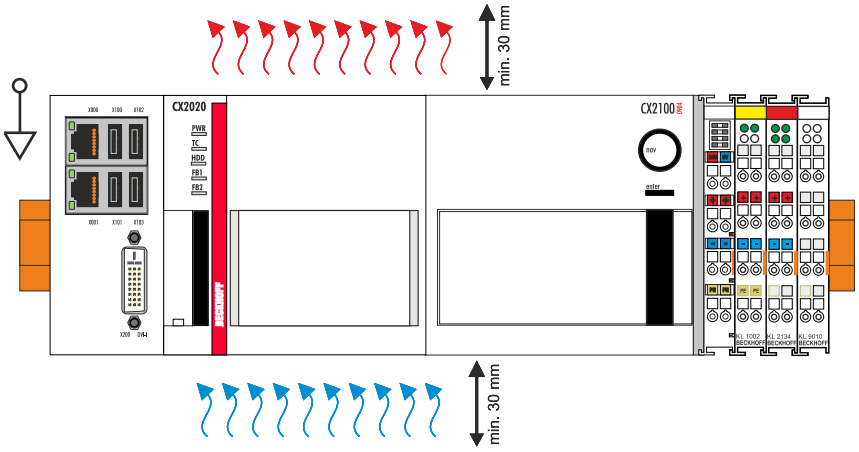


Fig. 3: CX2020 Embedded PC, horizontal installation position.

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

5.1.4 Attaching on mounting rail

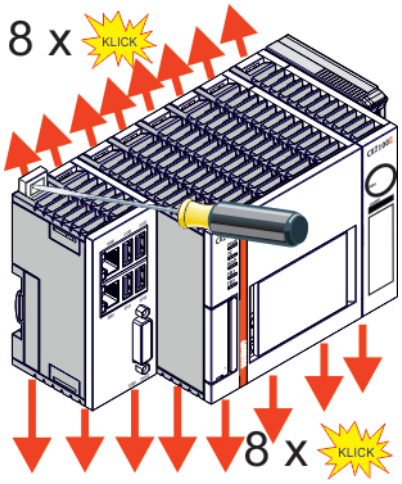
The housing is designed such that the Embedded PC can be pushed against the mounting rail and latched onto it.

Requirements:

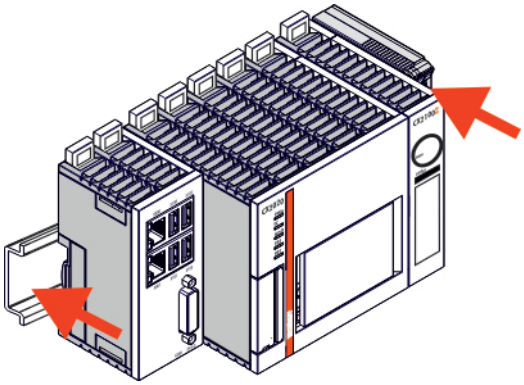
- Mounting rail of type TS35/7.5 or TS35/15 according to DIN EN 60715.

Secure the Embedded PC on the mounting rail as follows:

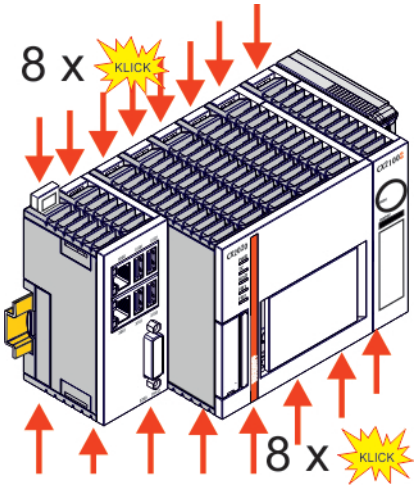
1. Unlock the latches at the top and bottom.



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



3. Then lock the latches again.



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

5.1.5 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.

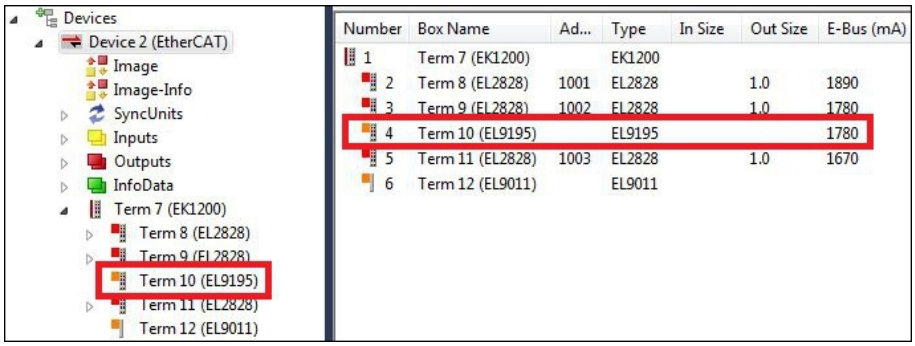


Fig. 4: Identifying a passive EtherCAT Terminal in TwinCAT.

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.

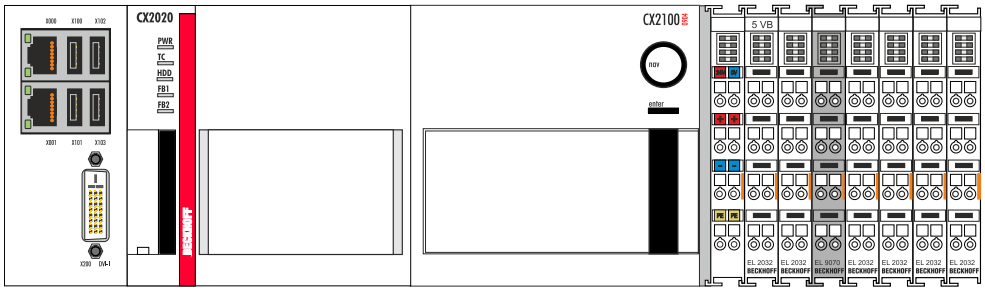


Fig. 5: Passive EtherCAT Terminals, permissible installation.

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

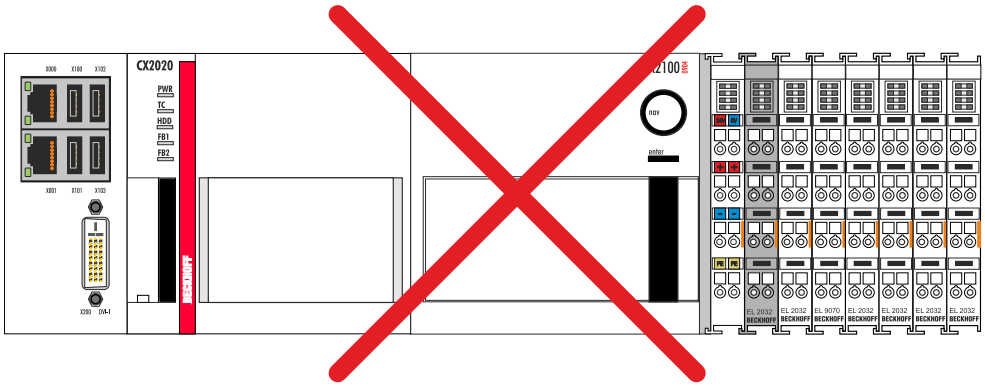


Fig. 6: Passive EtherCAT Terminals, invalid installation.

5.2 Power supply

This chapter describes how to connect the CX2100-0904 power supply unit. This documentation uses the CX2020 Embedded PC to demonstrate the procedure.

5.2.1 Connect Embedded PC

NOTICE

Damage to the Embedded PCs

The Embedded PCs may be damaged during wiring.

- The cables for the power supply should only be connected in de-energized state.

An external voltage source providing a 24 V DC voltage (-15 % / +20 %) is required for the CX2100-0904 power supply unit.

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

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

Connection example with CX2020 basic CPU module and CX2100-0904 power supply unit:

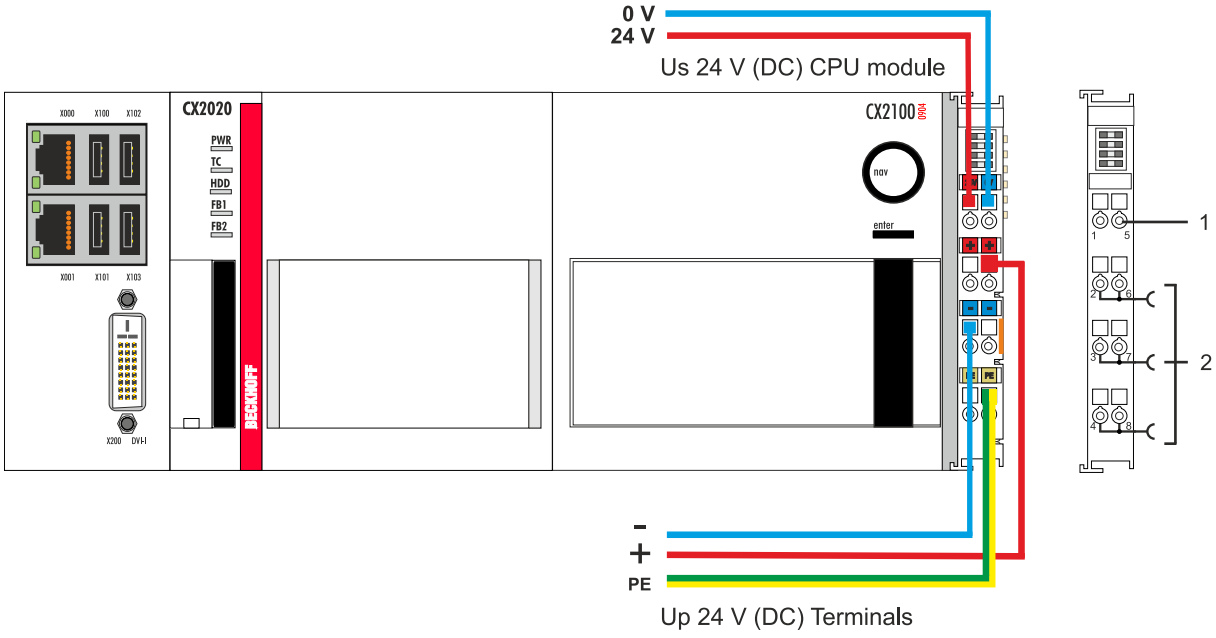


Table 6: Legend for the connection example.

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.

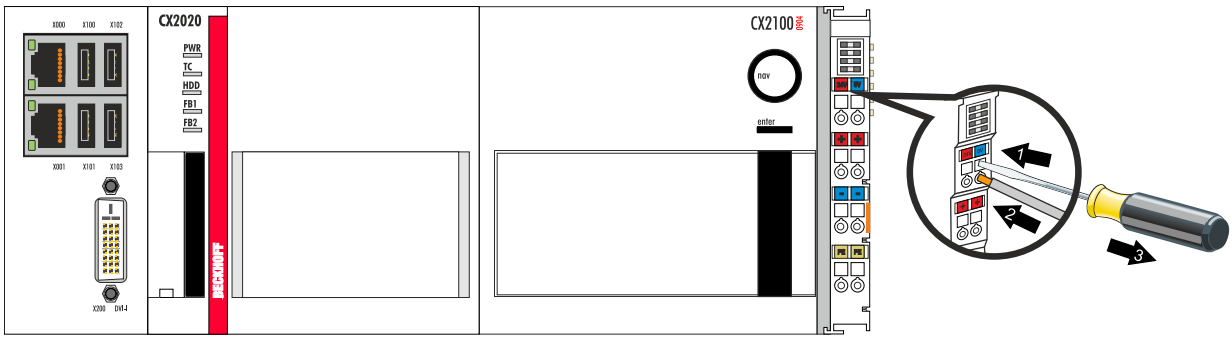
The cables of an external voltage source are connected to the power supply unit with spring-loaded terminals.

Table 7: Required wire cross-sections and strip lengths.

Conductor cross-section	0,5 ... 2,5 mm²	AWG 20 ... AWG 14
Strip length	8 ... 9 mm	0.33 inch

Connect the embedded PC as follows:

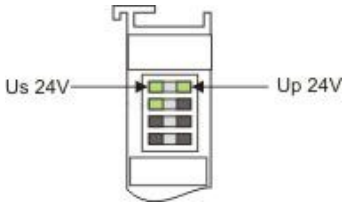
1. Open a spring-loaded terminal by slightly pushing with a screwdriver or a rod into the square opening above the terminal.



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.

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

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



NOTICE

Interrupting / switching off the power supply

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

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

5.2.2 Observe the UL requirements

Observe the UL requirements

The CX20xx Embedded PCs are UL certified. The corresponding UL label can be found on the type plate.

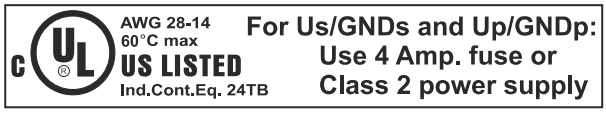
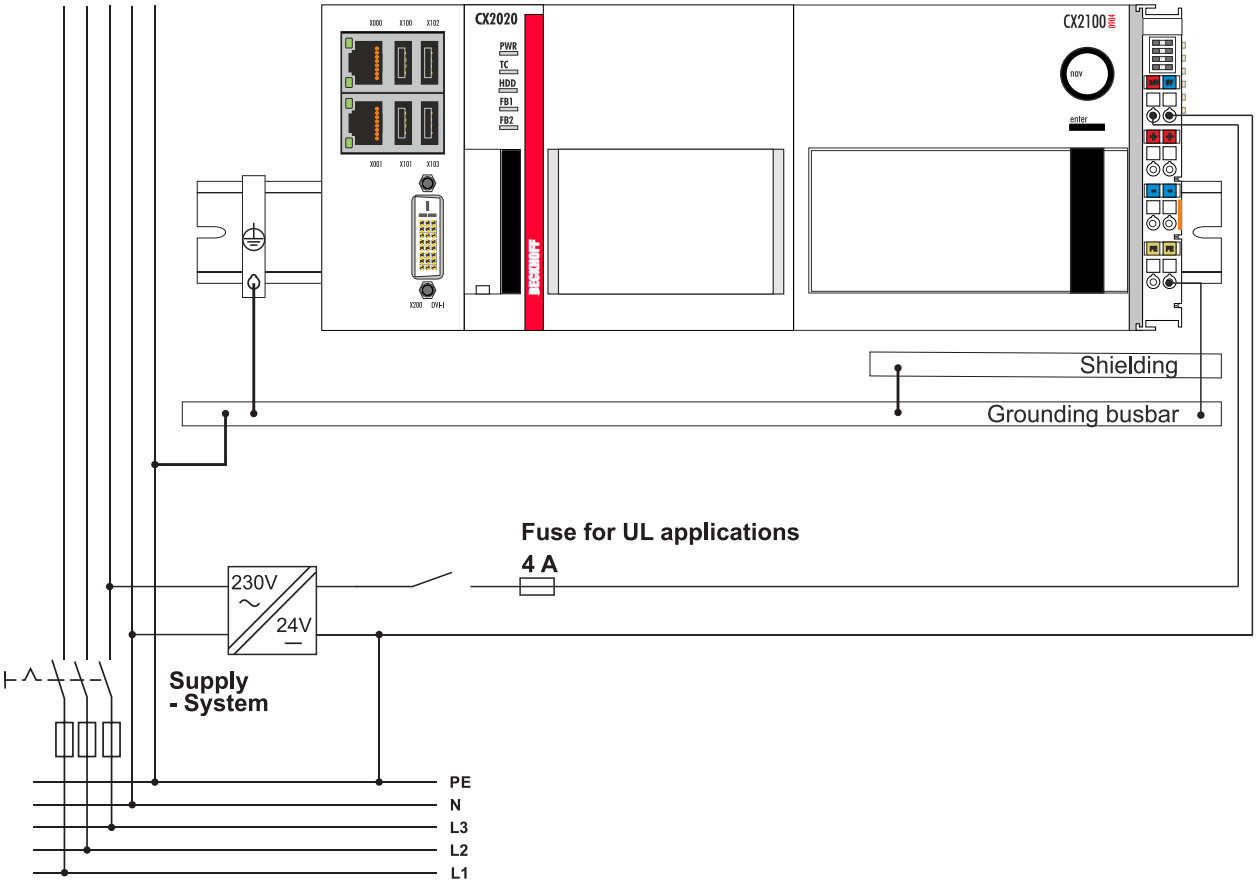


Fig. 7: UL label for CX20xx Embedded PC.

The CX20xx Embedded PCs can thus be used in areas in which special UL requirements have to be met. These requirements apply to the system voltage (Us) and to the power contacts (Up). Application areas 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.



6 Configuration

6.1 Display

The LCD display of the power supply unit has 2 x 16 characters. Each character has a resolution of 5 x 8 pixels. The display has a backlight that can be switched on and off. You can get a user's attention with a flashing display by quickly turning the backlight on and off. The control takes place via the PLC interface, ADS communication or the System Manager.

6.1.1 Character representation

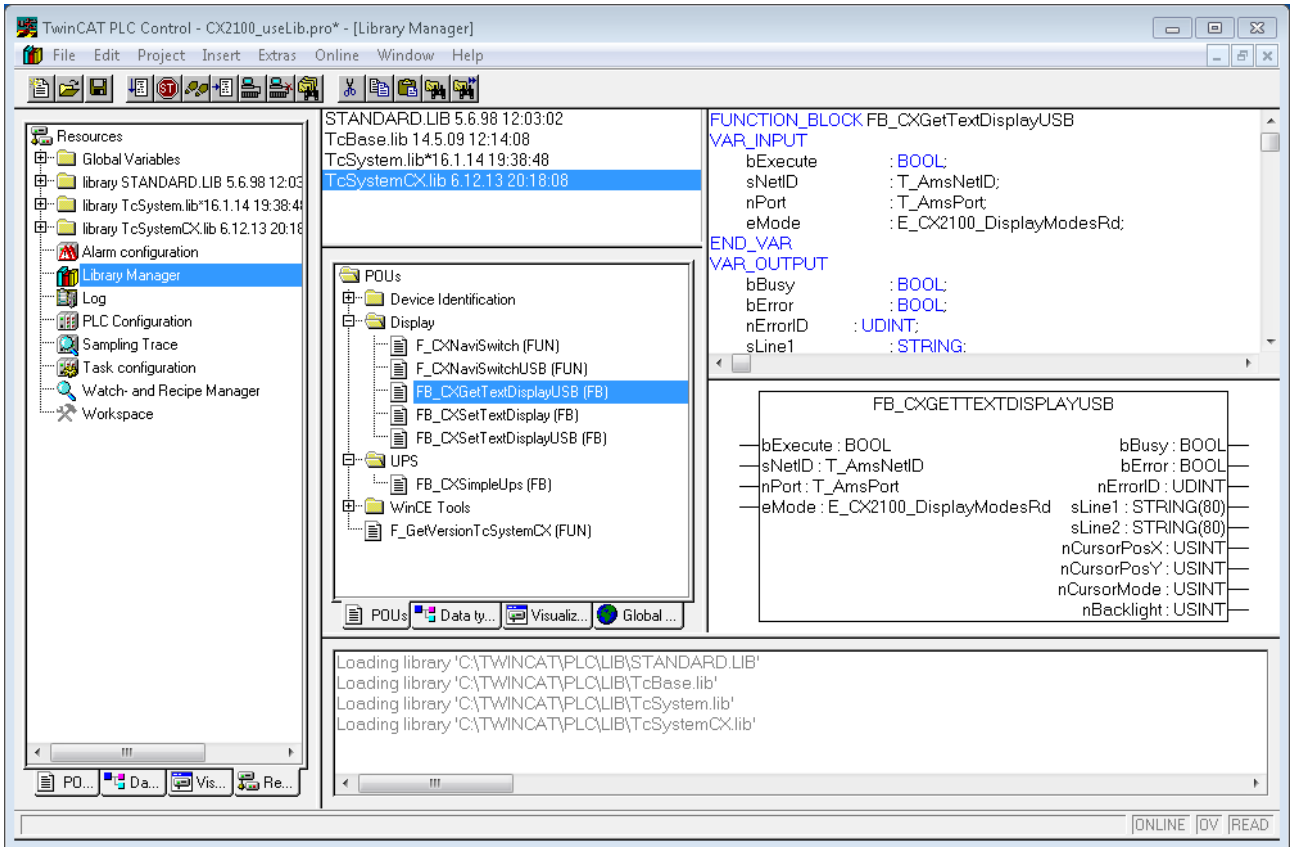
The displayable characters on the display correspond to ASCII / ISO 8859-1 from 0x20 to 0x7E.

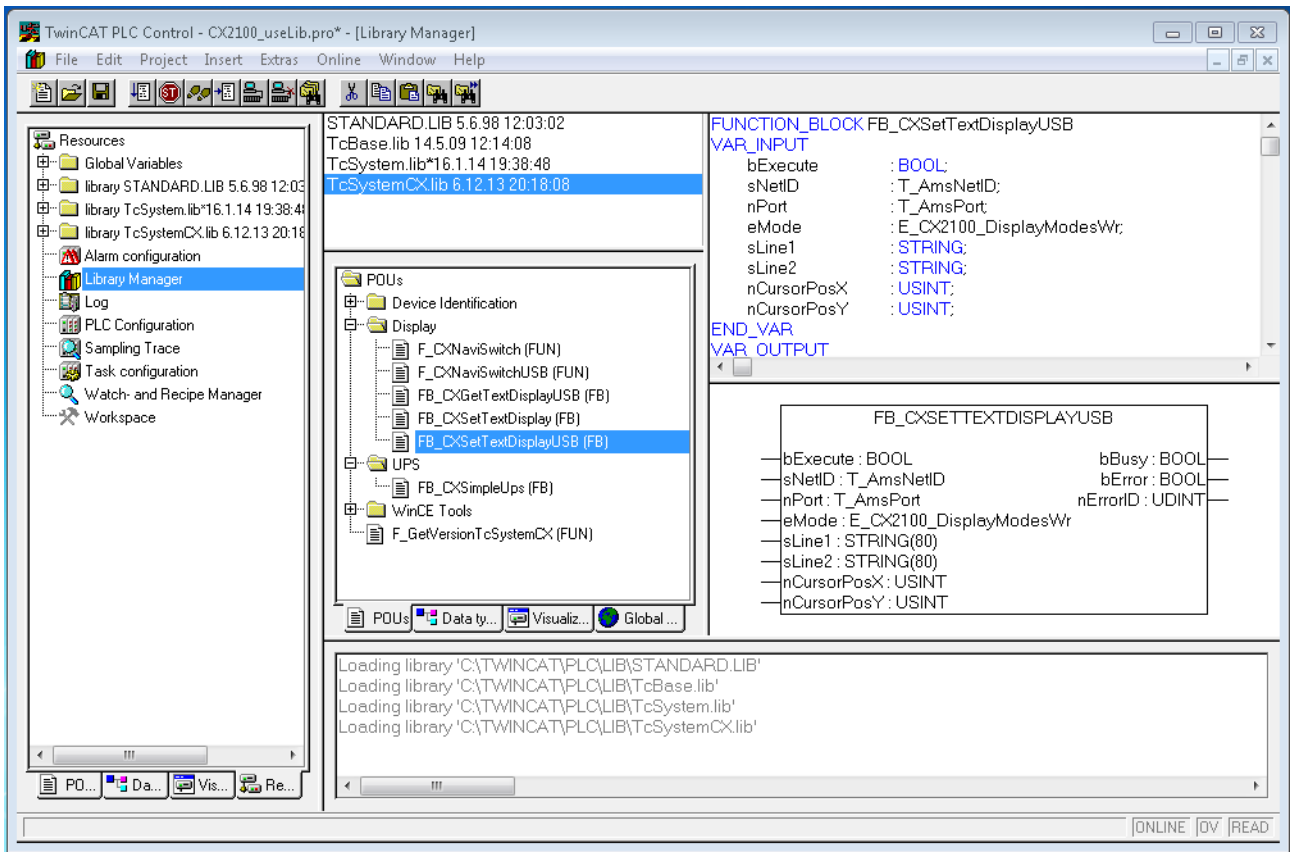
Hex	Character	Hex	Character	Hex	Character
0x20		0x40	@	0x60	`
0x21	!	0x41	A	0x61	a
0x22	"	0x42	B	0x62	b
0x23	#	0x43	C	0x63	c
0x24	$	0x44	D	0x64	d
0x25	%	0x45	E	0x65	e
0x26	&	0x46	F	0x66	f
0x27	'	0x47	G	0x67	g
0x28	(	0x48	H	0x68	h
0x29	)	0x49	I	0x69	i
0x2A	*	0x4A	J	0x6A	j
0x2B	+	0x4B	K	0x6B	k
0x2C	,	0x4C	L	0x6C	l
0x2D	-	0x4D	M	0x6D	m
0x2E	.	0x4E	N	0x6E	n
0x2F	/	0x4F	O	0x6F	o
0x30	0	0x50	P	0x70	p
0x31	1	0x51	Q	0x71	q
0x32	2	0x52	R	0x72	r
0x33	3	0x53	S	0x73	s
0x34	4	0x54	T	0x74	t
0x35	5	0x55	U	0x75	u
0x36	6	0x56	V	0x76	v
0x37	7	0x57	W	0x77	w
0x38	8	0x58	X	0x78	x
0x39	9	0x59	Y	0x79	y
0x3A	:	0x5A	Z	0x7A	z
0x3B	;	0x5B	[	0x7B	{
0x3C	<	0x5C	\	0x7C	|
0x3D	=	0x5D	]	0x7D	}
0x3E	>	0x5E	^	0x7E	~
0x3F	?	0x5F	_		

6.1.2 Displaying texts

Software connection for the display

There is a possibility to set static texts via the System Manager. Alternatively there are two TwinCAT function blocks. Their names are FB_CXSetTextDisplayUSB(FB) and FB_CXGetTextDisplayUSB(FB). Parameters are written with FB_CXSetTextDisplayUSB(FB) and the status values are read from the function block with FB_CXGetTextDisplayUSB(FB). A detailed documentation of the function blocks can be found in the TwinCAT software documentation. The two screenshots show the associated libraries for the function blocks.





Availability of the function blocks

These function blocks are available in the TwinCAT builds starting from version

TC2.11 R3 Build 2240
TC3.1 Build 4015

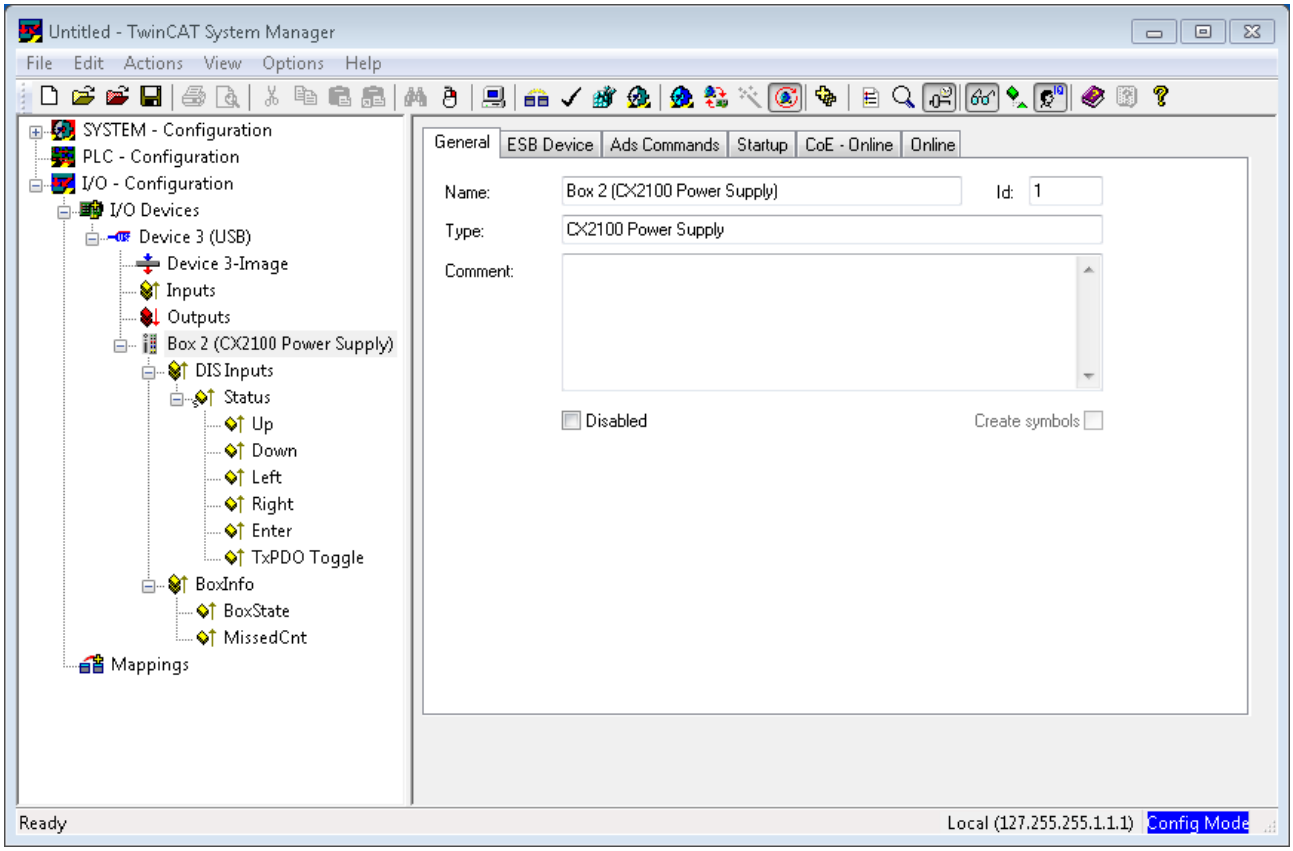
With older versions an update is required for the use of the function blocks.

Illustration of the display with the System Manager

There are six tabs in the System Manager. These are briefly described below. The focus is thereby placed on the parameter that is relevant for the power supply unit

Tab: General

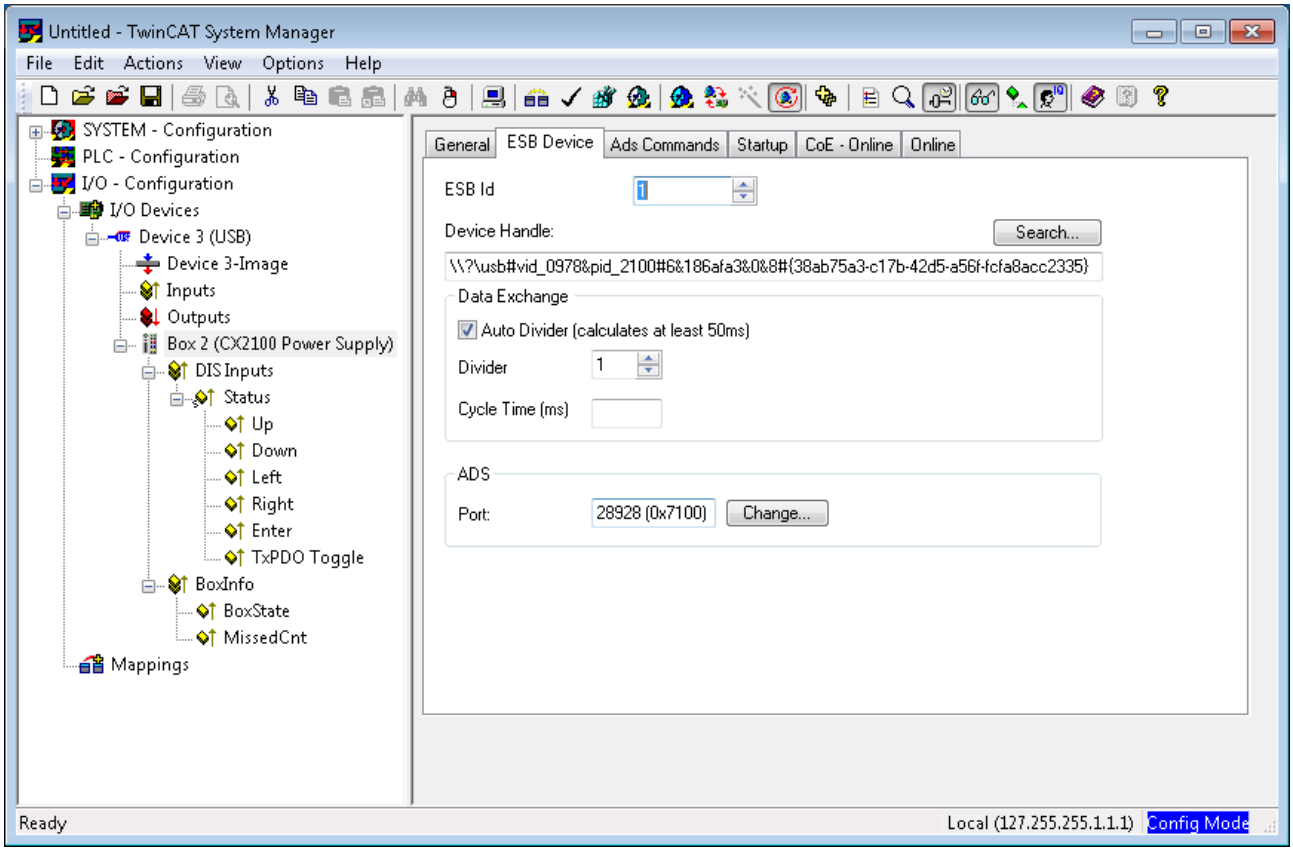
The general properties of the power supply unit are displayed here.



Name	Name of the EtherCAT device
Id	Number of the EtherCAT device
Type	EtherCAT device type
Comment	Here you can add a comment (e.g. regarding the system).
Disabled	Here you can deactivate the EtherCAT device.

Tab: ESB Device

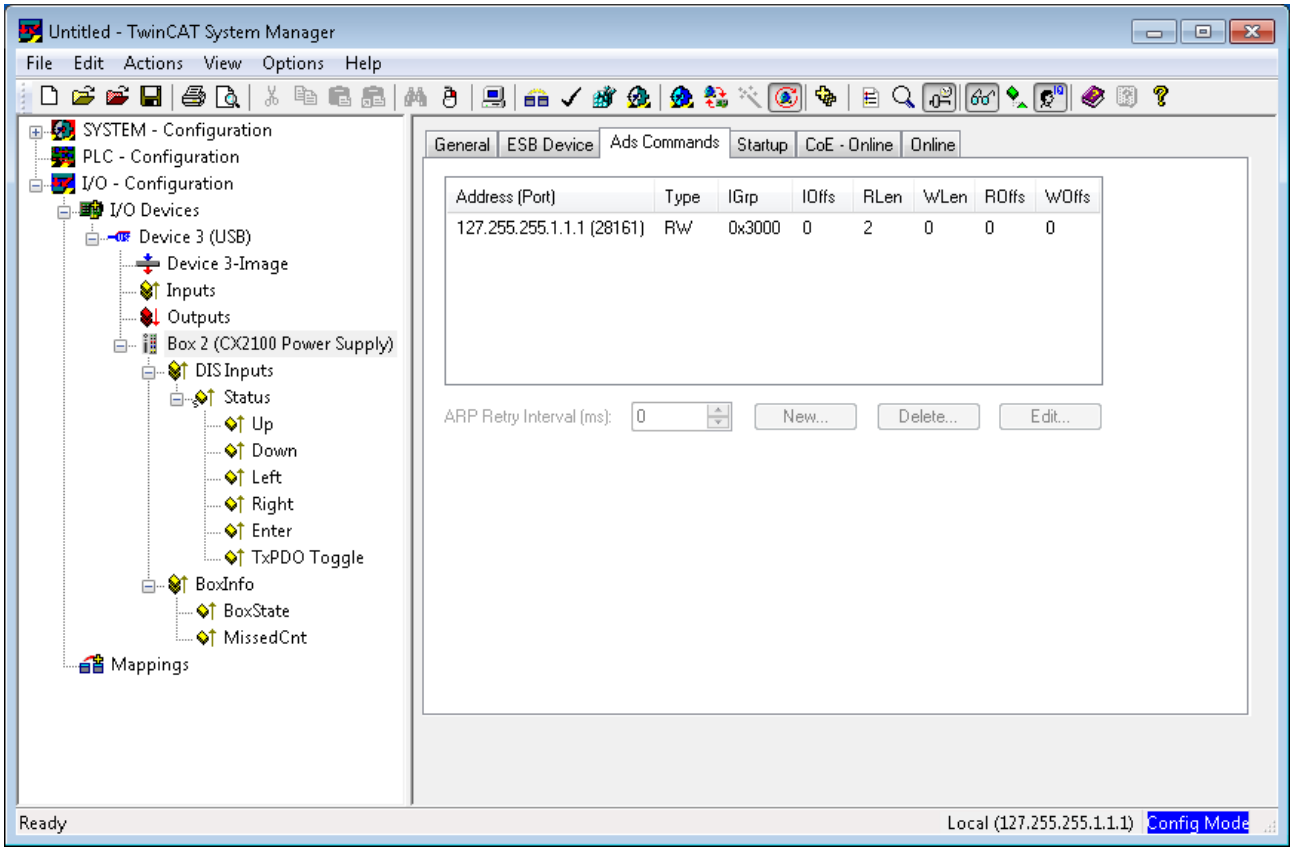
The settings for the exchange of data between the power supply unit and the system are made and/or displayed here.



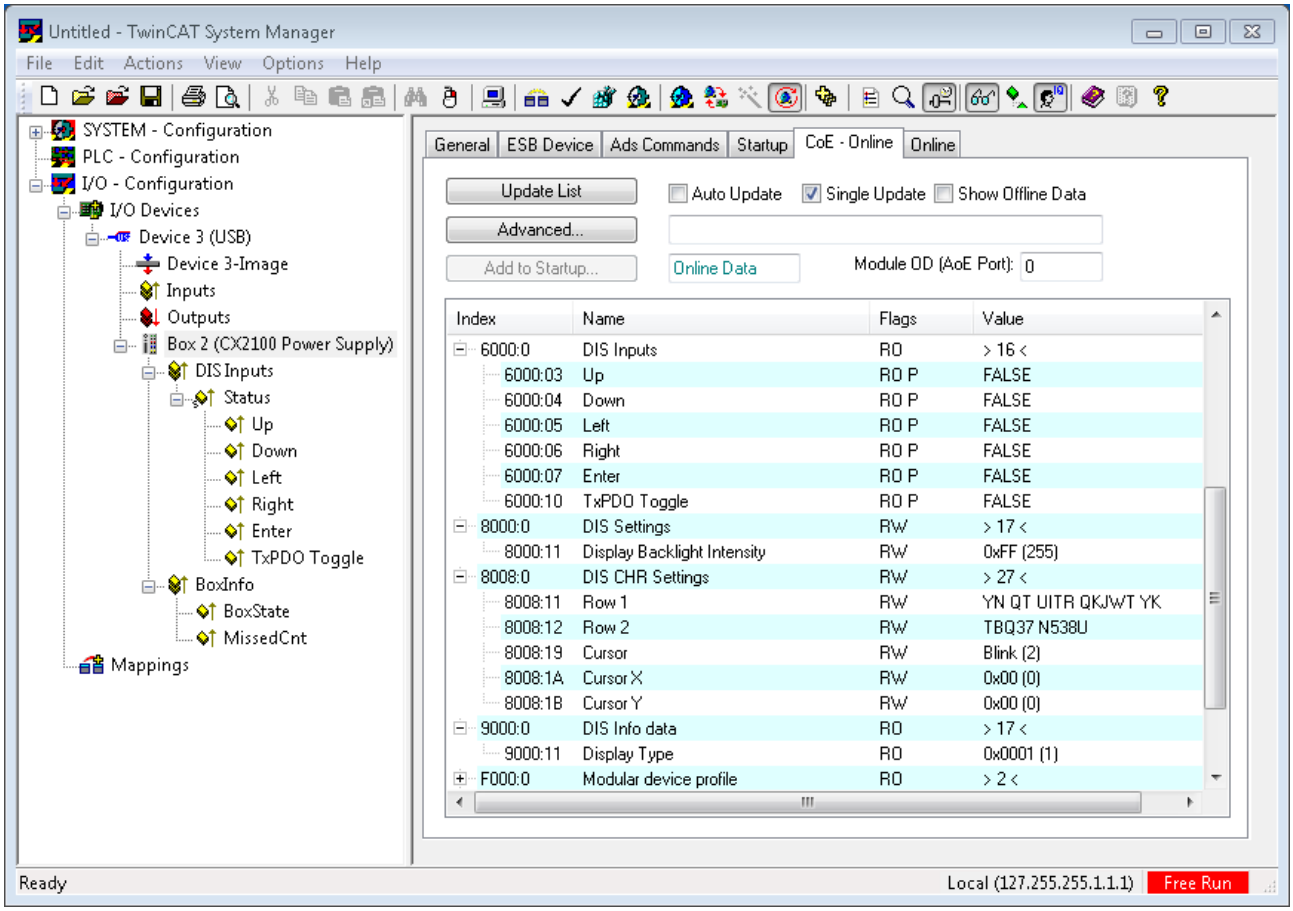
ESB Id	Serial numbers of the devices on the BUS
Device Handle	Pointer to the device driver
Data Exchange	Cycle in which the communication takes place
ADS	Port address for ADS access (7100 for the TwinCAT function block)

Tab: ADS Commands

The range for ADS communication is displayed here.



Tab: CoE Online



CoE interface – parameter management in the EtherCAT system

Many different devices are used in an automation environment. These devices can be used separately or together in a group on a bus system. Such devices can be controllers, shaft encoders, servo drives, motors, I/O modules or sensors among other things. Depending upon complexity, such a device must be parameterizable/adjustable for the respective requirement. Parameterization is perhaps not necessary in the case of a simple digital 24 V input with a fixed switching threshold and delay; in the case of a shaft encoder, however, it will not be possible to do without it (e.g. number of lines, absolute or relative, data format, etc.)
On top of that it can be of interest to store data in the device during production or operation. The manufacturer could store production data such as device name, serial number, firmware version, calibration data or date of manufacture, if necessary provided with protection against access or amendment. The user could store user calibration data and the application-specific settings in the device.
In order to create a user-friendly interface for device operation, different organizations have created various standards in which the following are defined: the available device classes (e.g.: 'rotary encoder', 'analog input module' class), the parameters that each representative of such a class has (obligatory and optional elements), the locations where these parameters can be found and the mechanism with which they are to be changed. EtherCAT follows the so called CoE standard here: Can-Application-protocol-over-EtherCAT.

Can-over-EtherCAT

The CiA organization (CAN in Automation) pursues among other things the goal of creating order and exchangeability between devices of the same type by the standardization of device descriptions. For this purpose so-called profiles are defined, which conclusively describe the changeable and unchangeable parameters of a device. Such a parameter encompasses at least the following characteristics:

- Index number – for the unambiguous identification of all parameters. The index number is divided into a main index and a subindex in order to mark and arrange associated parameters.
  - Main index
  - Subindex, (offset by a colon ":")
- Official name – in the form of an understandable, self-descriptive text
- Specification of changeability, e.g. whether it can only be read or can also be written
- A value – depending upon the parameter the value can be a text, a number or another parameter index.

Example: the parameter 'Vendor ID' might have the index number 4120:01 and the numerical value '2' as the ID of a Beckhoff device.
Since hexadecimal values are favored in the machine environment, the parameter is represented from the user's point of view as if it had the RO property (read only), because the vendor ID should not be changed by the user.

Such a list of parameters, the whole of the device-specific CoE directory, can become very extensive. The first entries of a Beckhoff EL3152 analog input terminal appear as follows in the TwinCAT System Manager:

The index numbers are specified in the profile; they begin in EtherCAT with x1000, because the underlying entries do not have to be displayed.

CoE directory – availability

An EtherCAT device can have a CoE directory, but does not need to have one. Simple slaves need no parameter directory or do not have the controller required for administration. On the other hand, the EtherCAT master (like TwinCAT) as a software EtherCAT device can also manage a CoE directory.

If present, the CoE directory is in operation from the PREOP state.

The object directory can be read via the SDO information service (Service Data Objects).

CoE directory – localization in the EtherCAT Slave

The CoE directory as a parameter system must be administrated in the device in the firmware (FW) in the local controller. This is the so-called *online directory*, because it is only available to the user if the EtherCAT slave is in operation with operating voltage supplied and, if applicable, can be manipulated via EtherCAT communication.

So that the parameters can be viewed and changed in advance without the presence of a slave, a default copy of the entire directory is usually stored in the device description file ESI (XML). This is called the *offline directory*. Changes in this directory do not affect the later operation of the slave with TwinCAT. The xml files can be obtained from the Beckhoff website in the Download area.

The TwinCAT system manager 2.11 can display both lists and marks this:

in the online directory	**in the offline directory**
the actual current slave list is read. This may take several seconds, depending on the size and cycle time	the offline list from the ESI file is displayed. In this case modifications are not meaningful or possible.
the actual identity is displayed	the configured status is shown under Identity
the firmware and hardware version of the equipment according to the electronic information is displayed	no firmware or hardware version is displayed, since these are features of the physical device
a green **online** is visible in the TwinCAT System Manager, *CoE Online* tab	a red **offline** is visible in the TwinCAT System Manager, *CoE Online* tab

Classification

Different CoE parameter types are possible, including string (text), integer numbers, Boolean values or larger byte fields. They can be used to describe a wide range of features. Examples of such parameters include manufacturer ID, serial number, process data settings, device name, calibration values for analog measurement or passwords.

The ranges in the Slave CoE that are important for the application-oriented EtherCAT fieldbus user are

- x1000: This is where fixed identity information for the device is stored, including name, manufacturer, serial number etc., plus information about the current and available process data configurations.
- x8000: This is where the operational and functional parameters for all channels are stored, such as filter settings or output frequency.

The following ranges are also of interest

- x4000: In some EtherCAT devices the channel parameters are stored here (as an alternative to the x8000 range).
- x6000: Input PDOs ("input" from the perspective of the EtherCAT master)
- x7000: Output PDOs ("output" from the perspective of the EtherCAT master)

Channel-based order

The CoE directory is located in EtherCAT devices that usually encompass several functionally equivalent channels. e.g. a 4-channel 0 – 10 V analog input terminal also has 4 logical channels and thus 4 identical sets of parameter data for the channels. In order to avoid having to list each channel in the documentation, the placeholder "n" tends to be used for the individual channel numbers.

In the CoE system 16 indices, each with 255 subindices, are generally sufficient for representing all channel parameters. The channel-based order is therefore arranged in $16_{dec}/10_{hex}$ steps. The parameter range x8000 exemplifies this:

Channel 0: parameter range x8000:00 ... x800F:255

Channel 1: parameter range x8010:00 ... x801F:255

Channel 2: parameter range x8020:00 ... x802F:255

tbc...

This is generally written as x80n0.

CoE directory – changes of value

Several parameters, in particular the setting parameters of the slave, are variable and can be written by the user from the fieldbus side. This can be done in write or read mode

via the System Manager (fig. 3) by the operator clicking on it
The values are then changed directly in the online-connected slave.
This is useful for commissioning of the system/slaves. Click on the row of the index to be parameterized and enter a value in the "SetValue" dialog.

from the controller/PLC via ADS e.g. by the function blocks from the TcEtherCAT.lib library
This is recommended for modifications when the system is running or if no System Manager or operating staff are available.

during the EtherCAT startup through predefined commands, the so-called startup list.
The TwinCAT configuration is usually created in advance without EtherCAT slaves actually being present. Then it should be possible before commissioning to adjust known properties such as filter settings offline in order to accelerate commissioning.

CoE directory – startup list

Start-up list

Changes made to the local CoE directory of the EtherCAT slaves are lost with the old device in case of exchange. If a device is replaced with a new Beckhoff device, it will have the default settings. It is therefore advisable to link all changes in the CoE list of an EtherCAT slave with the Startup list of the slave, which is processed whenever the EtherCAT fieldbus is started. In this way a replacement EtherCAT slave can automatically be parameterized with the specifications of the user.
If EtherCAT slaves are used which are unable to store local CoE values permanently, the Startup list must be used.

The startup list is used for these cases: the values here, which are entered by the user, are transmitted to the respective slave upon each EtherCAT state transition/start. A startup entry consists of

- Time: the state transition in which the command is sent
  PS (PREOP-->SAFEOP) is usually the correct choice, since an EtherCAT slave then switches to operative input mode.
- Index:Subindex
- Data

The order of the entries is not taken into account: all entries to which a state transition applies are handed over simultaneously as asynchronous commands to the EtherCAT system and executed there, as soon as the bus load allows. No check is made of whether an identical entry is already present in the slave. The corresponding values are adopted upon clicking the entry 8000:01; 01 is entered in *Data* as the desired value. The entry ‘P->S’ marks the time of the execution.

CoE directory – data management

Data management

If slave CoE parameters are modified online, Beckhoff devices store any changes in a fail-safe manner in the EEPROM, i.e. the modified CoE parameters are still available after a restart.

The situation may be different with other manufacturers.

If EtherCAT slaves are used which are unable to store local CoE values permanently, the Startup list must be used.

Summary of the characteristics

Not every EtherCAT device must have a CoE directory

If a CoE directory is present, it is administrated, prepared for querying and writing and stored in the device by the controller.

The EtherCAT master can be used for viewing/querying/changing, or a local user interface on the device (keypad, screen) allows access.

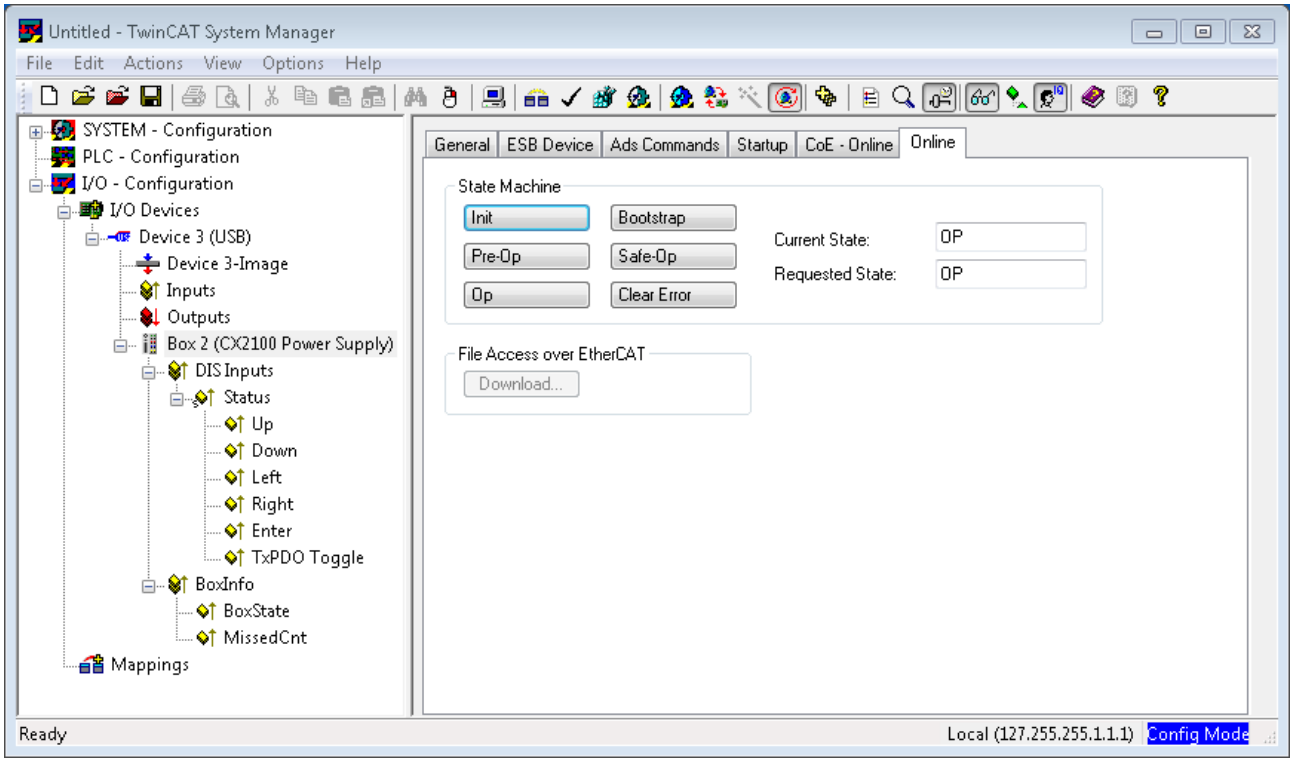
Changed settings are stored fail-safe in Beckhoff devices.
If the device is later exchanged, however, the settings that have been changed from the series standard are lost. The EtherCAT master can then load the changed CoE parameters into the new device at startup, if it is set up appropriately.

So that a CoE directory is available offline during the preparation for configuration, it can be contained in the device description as a copy.

The extent to which the CoE directory is supported depends on the capabilities of the EtherCAT master.

Tab: Online

the state machine of the EtherCAT communication is displayed here. It can also be switched to a different state here. This is done by selecting the desired state by a mouse-click on the appropriate button. The individual states are briefly described below. For further information, please refer to the EtherCAT system description on our webpage.



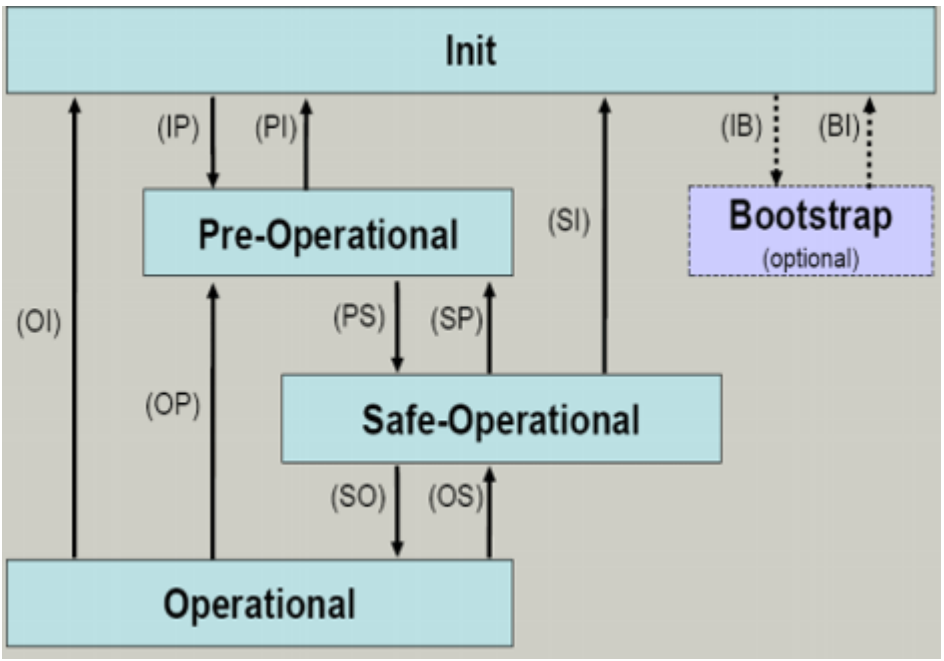
EtherCAT State Machine

The state of the EtherCAT slave is controlled via the EtherCAT State Machine (ESM). Depending upon the state, different functions are accessible or executable in the EtherCAT slave. Specific commands must be sent by the EtherCAT master to the device in each state, particularly during the bootup of the slave.

A distinction is made between the following states:

- Init
- Pre-Operational
- Safe-Operational and
- Operational
- Boot

The regular state of each EtherCAT slave after bootup is the OP state.



Init

After switch-on the EtherCAT slave in the Init state. No mailbox or process data communication is possible. The EtherCAT master initializes sync manager channels 0 and 1 for mailbox communication.

Pre-Operational (Pre-Op)

During the transition from Init to Pre-Op, the EtherCAT slave checks whether the mailbox has been correctly initialized. Mailbox communication is possible in the Pre-Op state, but no process data communication. The EtherCAT master initializes the sync manager channels for process data (from sync manager channel 2), the FMMU channels and, if the slave supports configurable mapping, PDO mapping or the sync manager PDO assignment. In this state the settings for the process data transfer and perhaps terminal-specific parameters that may differ from the default settings are also transferred.

Safe-Operational (Safe-Op)

During transition between Pre-Op and Safe-Op the EtherCAT slave checks whether the sync manager channels for process data communication and, if required, the distributed clocks settings are correct. Before it acknowledges the change of state, the EtherCAT slave copies current input data into the associated DP-RAM areas of the EtherCAT slave controller (ECSC).

Mailbox and process data communication are possible in the Safe-OP state; however, the slave maintains its outputs in the safe state and does not output them. The input data, however, are already cyclically updated.

Operational (Op)

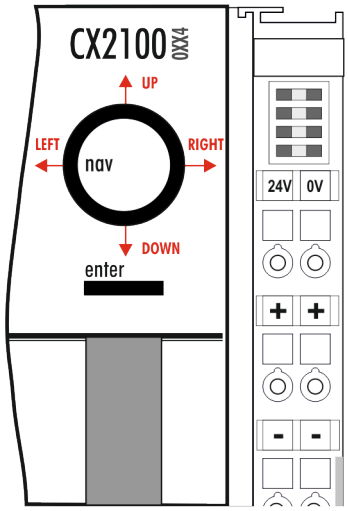
Before the EtherCAT master switches the EtherCAT Slave from *Safe-Op* to *Op*, it must transmit already valid output data. In the *Op* state the slave copies the output data of the master to its outputs. Process data and mailbox communication is possible.

Boot

In the *Boot* state the slave firmware can be updated. The *Boot* state can only be reached via the *Init* state. In the *Boot* state mailbox communication is possible via the *File-Access over EtherCAT* (FoE) protocol, but no other mailbox communication and no process data communication is possible.

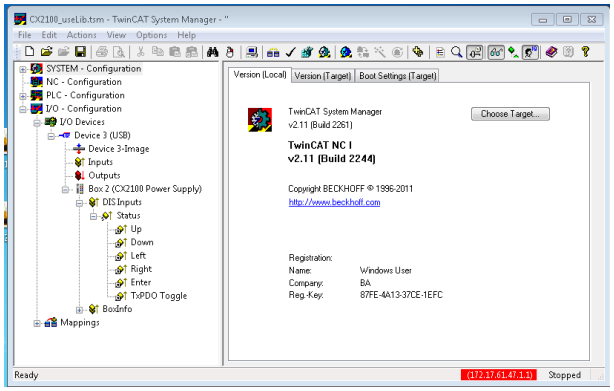
6.2 Operating principle of the button

The CX1100-0xx4 power supply units all have four navigation switches and an Enter button. The buttons can therefore be used to input five basic states



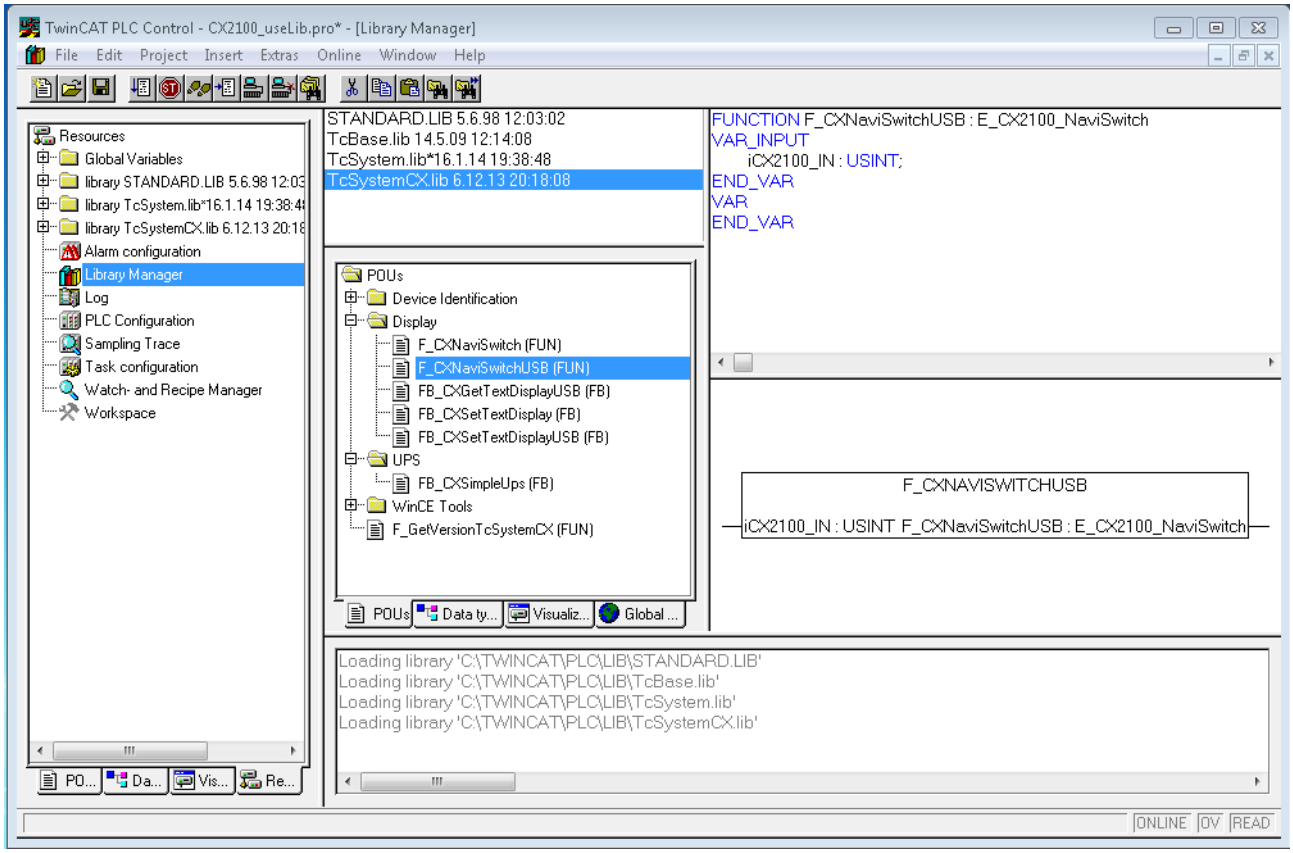
Button	Value	Button	Value
UP	4	RIGHT	32
DOWN	8	ENTER / SELECT	64
LEFT	16		

Combined inputs, such as UP + RIGHT or UP + RIGHT + ENTER can also be entered. Each value is made available separately as a boolean value and can be linked in the PLC.



The values of the button can be assessed as a numerical value via a TwinCAT function. A combination of the buttons can also be assessed via the value. The register can be accessed from within a PLC program, and the value can be assessed. This requires a variable of type USINT first to be created in the PLC program. This is then called as a parameter in the 'F_CXNaviSwitchUSB' function. The code fragment shows the declaration of the required variables.

```
PROGRAM MAIN
VAR
    bUp AT %I*        : BOOL;
    bDown AT %I*    : BOOL;
    bLeft AT %I*    : BOOL;
    bRight AT %I*    : BOOL;
    bEnter AT %I* : BOOL;
    bToggle AT %I*    : BOOL;
    Taster        : USINT; (* als Summenwert *)
    eNaviSwitchCx2 : E_CX2100_NaviSwitch;
END_VAR
```




```
(* get navi switch *)
eNaviSwitchCx2 := F_CXNaviSwitchUSB(Taster);
```

The button can be accessed from the PLC program through the button variable. A simple CASE statement can then be used to evaluate the switch, and the desired function can be initiated, e.g.:

```
CASE Taster OF
    4 : ACTION  := UP;
    8 : ACTION  := DOWN;
    16: ACTION  := LEFT;
    32: ACTION  := RIGHT;
    64: ACTION  := SELECT;
END_CASE;
```

In this case, "ACTION" is a newly defined ENUM type. It is also possible for the desired action to be activated immediately.

The sum of the numerical values is used for the combined functions. In other words, UP (4) and RIGHT (32) would be 4 + 32 = 36. Values are: {UP (4), DOWN(8), LEFT(16), RIGHT(32) and ENTER(64)}. In this way only useful combinations are possible.

6.3 Example Program

The following PLC program shows by way of an example how the three function blocks are used for the power supply unit.

```
PROGRAM MAIN

VAR
    nCounter AT %Q*: USINT;
    (* navi switch *)
    bUp AT %I*        : BOOL;
    bDown AT %I*    : BOOL;
    bLeft AT %I*    : BOOL;
    bRight AT %I*    : BOOL;
    bEnter AT %I*    : BOOL;
    bToggle AT %I*    : BOOL;
    nIn            : USINT;
    eNaviSwitchCx2    : E_CX2100_NaviSwitch;

    (* get display *)
    fbGetDisplayText     : FB_CXGetTextDisplayUSB;
    bExecuteRead        : BOOL;
    eModeRead            : E_CX2100_DisplayModesRd;
    nCursorMode        : USINT;
    nBacklight            : USINT;
    bReadCursorInfoReq    : BOOL := TRUE;
    bReadBacklightReq    : BOOL := TRUE;
    bReadLine1Req        : BOOL;
    bReadLine2Req        : BOOL;
    bReadLinesReq        : BOOL := TRUE;

    (* set display *)
    fbSetDisplayText    : FB_CXSetTextDisplayUSB;
    bExecuteWrite        : BOOL;
    eModeWrite            : E_CX2100_DisplayModesWr;
    bCursorOnReq        : BOOL;
    bCursorOffReq        : BOOL;
    bBlinkCursorOnReq    : BOOL;
    bBlinkCursorOffReq    : BOOL;
    bBacklightOnReq        : BOOL;
    bBacklightOffReq    : BOOL;
    bClearDisplayReq    : BOOL;
    bWriteLine1Req        : BOOL;
    bWriteLine2Req        : BOOL;
    bWriteLinesReq        : BOOL;
    bSetCursorPosXReq    : BOOL;
    bSetCursorPosYReq    : BOOL;
    bSetCursorPosXYReq    : BOOL;

    (* common *)
    nCursorPosX    : USINT;
    nCursorPosY    : USINT;
    sLine1        : STRING;
    sLine2        : STRING;
    bBusy         : BOOL;
    bError        : BOOL;
    nErrorID        : UDINT;
END_VAR

nCounter := nCounter + 1;

nIn.2 := bUp;
nIn.3 := bDown;
nIn.4 := bLeft;
nIn.5 := bRight;
nIn.6 := bEnter;

(* get navi switch *)
eNaviSwitchCx2 := F_CXNaviSwitchUSB(nIn);

(* prepare get display mode *)
IF (eModeRead = eCX2100_DisplayNoActionRd) AND (eModeWrite = eCX2100_DisplayNoActionWr) THEN
    IF bReadCursorInfoReq THEN
        eModeRead := eCX2100_ReadCursorInfo;
        bExecuteRead := TRUE;
    ELSIF bReadBacklightReq THEN
        eModeRead := eCX2100_ReadBackLight;
        bExecuteRead := TRUE;
    ELSIF bReadLine1Req THEN
```

```
        eModeRead := eCX2100_ReadLine1;
        bExecuteRead := TRUE;
    ELSIF bReadLine2Req THEN
        eModeRead := eCX2100_ReadLine2;
        bExecuteRead := TRUE;
    ELSIF bReadLinesReq THEN
        eModeRead := eCX2100_ReadLines;
        bExecuteRead := TRUE;
    END_IF
END_IF

(* get display *)

IF (eModeRead <> eCX2100_DisplayNoActionRd) AND (eModeWrite = eCX2100_DisplayNoActionWr) THEN
    fbGetDisplayText(
        bExecute := bExecuteRead,
        sNetID := '',
        nPort     := 16#7100,
        eMode     := eModeRead,
        bBusy     => bBusy,
        bError    => bError,
        nErrorID => nErrorID,
    );
    IF NOT fbGetDisplayText.bBusy THEN
        fbGetDisplayText(bExecute := FALSE);
        IF NOT fbGetDisplayText.bError THEN
            CASE eModeRead OF
            eCX2100_ReadCursorInfo:
                nCursorPosX    := fbGetDisplayText.nCursorPosX;
                nCursorPosY    := fbGetDisplayText.nCursorPosY;
                nCursorMode    := fbGetDisplayText.nCursorMode;
                bReadCursorInfoReq := FALSE;
            eCX2100_ReadBackLight:
                nBacklight        := fbGetDisplayText.nBacklight;
                bReadBacklightReq := FALSE;
            eCX2100_ReadLine1:
                sLine1        := fbGetDisplayText.sLine1;
                bReadLine1Req    := FALSE;
            eCX2100_ReadLine2:
`                sLine2        := fbGetDisplayText.sLine2;
                bReadLine2Req    := FALSE;
            eCX2100_ReadLines:
                sLine1        := fbGetDisplayText.sLine1;
                sLine2        := fbGetDisplayText.sLine2;
                bReadLinesReq    := FALSE;
            END_CASE
        END_IF

        bExecuteRead        := FALSE;
        eModeRead        := eCX2100_DisplayNoActionRd;
    END_IF
END_IF

(* prepare set display mode *)
IF (eModeWrite = eCX2100_DisplayNoActionWr) AND (eModeRead = eCX2100_DisplayNoActionRd) THEN
    IF bCursorOnReq THEN
        eModeWrite        := eCX2100_CursorOn;
        bExecuteWrite    := TRUE;
        bReadCursorInfoReq := TRUE;
    ELSIF bCursorOffReq THEN
        eModeWrite        := eCX2100_CursorOff;
        bExecuteWrite     := TRUE;
        bReadCursorInfoReq := TRUE;
    ELSIF bBlinkCursorOnReq THEN
        eModeWrite     := eCX2100_CursorBlinkOn;
        bExecuteWrite     := TRUE;
        bReadCursorInfoReq := TRUE;
    ELSIF bBlinkCursorOffReq THEN
        eModeWrite     := eCX2100_CursorBlinkOff;
        bExecuteWrite     := TRUE;
        bReadCursorInfoReq := TRUE;
    ELSIF bBacklightOnReq THEN
        eModeWrite     := eCX2100_BackLightOn;
        bExecuteWrite     := TRUE;
        bReadBacklightReq := TRUE;
    ELSIF bBacklightOffReq THEN
        eModeWrite     := eCX2100_BackLightOff;
        bExecuteWrite     := TRUE;
        bReadBacklightReq := TRUE;
```

```
    ELSIF bClearDisplayReq THEN
        eModeWrite     := eCX2100_ClearDisplay;
        bExecuteWrite     := TRUE;
        bReadLinesReq    := TRUE;
    ELSIF bWriteLine1Req THEN
        eModeWrite     := eCX2100_WriteLine1;
        bExecuteWrite     := TRUE;
        bReadLine1Req    := TRUE;
    ELSIF bWriteLine2Req THEN
        eModeWrite     := eCX2100_WriteLine2;
        bExecuteWrite     := TRUE;
        bReadLine2Req    := TRUE;
    ELSIF bWriteLinesReq THEN
        eModeWrite     := eCX2100_WriteLines;
        bExecuteWrite     := TRUE;
        bReadLinesReq    := TRUE;
    ELSIF bSetCursorPosXReq THEN
        eModeWrite     := eCX2100_CursorPosX;
        bExecuteWrite     := TRUE;
        bReadCursorInfoReq := TRUE;
    ELSIF bSetCursorPosYReq THEN
        eModeWrite     := eCX2100_CursorPosY;
        bExecuteWrite     := TRUE;
        bReadCursorInfoReq := TRUE;
    ELSIF bSetCursorPosXYReq THEN
        eModeWrite     := eCX2100_CursorPosXY;
        bExecuteWrite     := TRUE;
        bReadCursorInfoReq := TRUE;
    END_IF
END_IF

(* set display *)
IF (eModeWrite <> eCX2100_DisplayNoActionWr) AND (eModeRead = eCX2100_DisplayNoActionRd) THEN
    fbSetDisplayText(
        bExecute     := bExecuteWrite,
        sNetID    := '',
        nPort        := 16#7100,
        eMode        := eModeWrite,
        sLine1     := sLine1,
        sLine2     := sLine2,
        nCursorPosX := nCursorPosX,
        nCursorPosY := nCursorPosY,
        bBusy        => bBusy,
        bError    => bError,
        nErrorID    => nErrorID
    );
    IF NOT fbSetDisplayText.bBusy THEN
        fbSetDisplayText(bExecute := FALSE);

        bExecuteWrite := FALSE;
        eModeWrite := eCX2100_DisplayNoActionWr;
    END_IF
END_IF
```

6.4 Configuration of the CX2100-0904 Integrated 24 V UPS

Under Windows Vista or Windows 7 you can reach the UPS configuration dialog via the link in the Start menu:

Start->All Programs->BECKHOFF->UPS Software Components->UPS Configuration

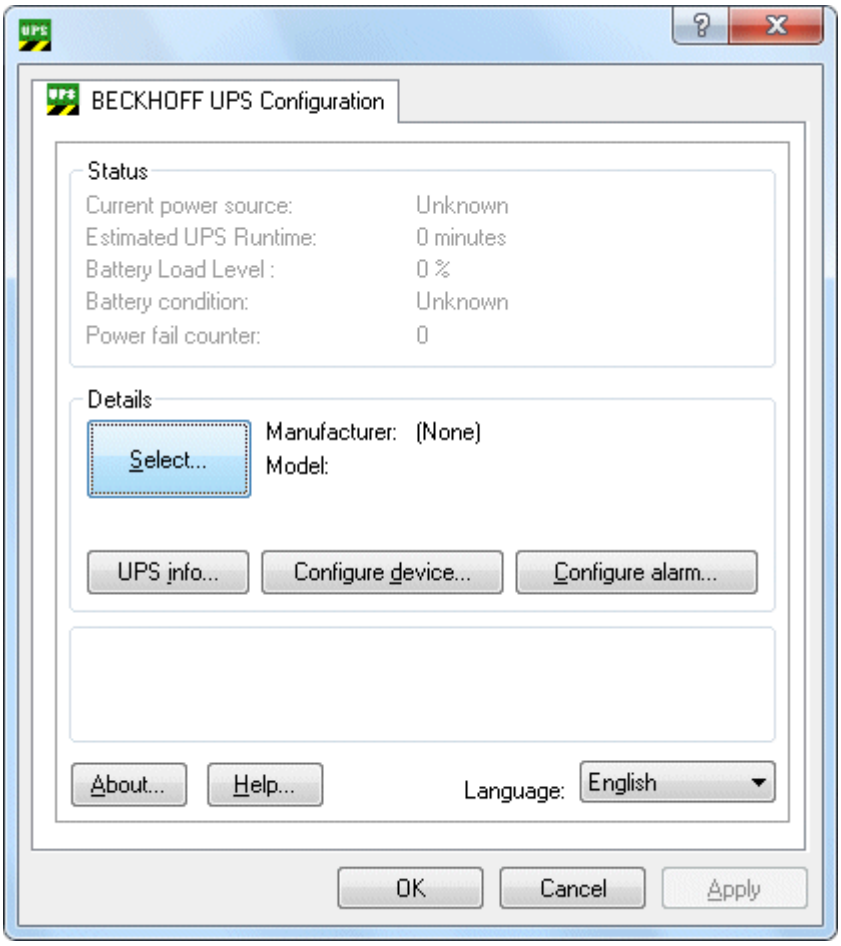
The UPS configuration settings can be made solely by a user with administrator rights. The corresponding dialogs are disabled for other users.

Language selection: From UPS software version >= 2.0.0.9 the language of the UPS dialogs can be selected at runtime. The language settings are permanently stored for all users if they have been changed by a user with administrator rights. All other users can change the language, but the setting is not permanently saved.

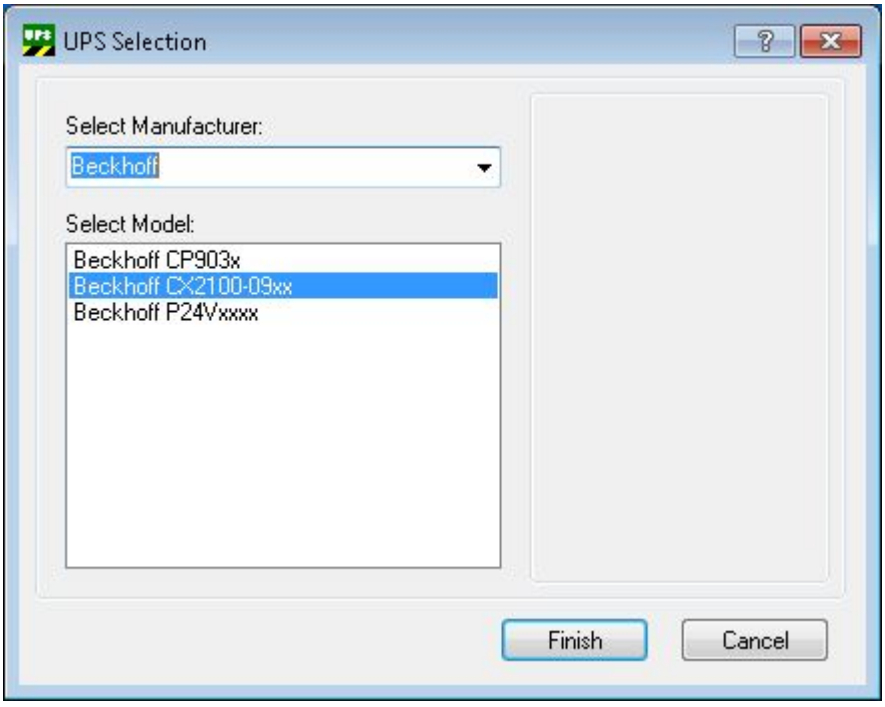
The *'User Default'* language setting has a special meaning. It is recommended to use this setting on an operating system with a Multilingual User Interface (MUI). The UPS dialog then appears automatically in the language that you have set under Control Panel -> Regional Settings for the UI dialogs.

If a language is not supported by the Beckhoff UPS dialog, the dialog appears in US English.

1. Open the *BECKHOFF UPS configuration dialog*, and then go to *Select*....

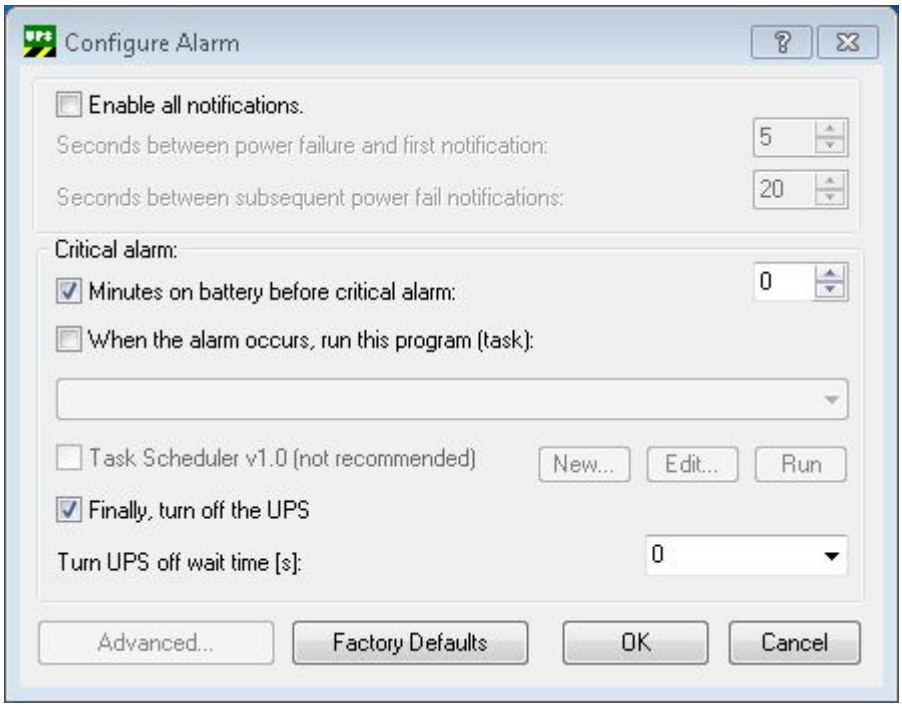


2. From the list of the manufacturers select *Beckhoff* and as the model *Beckhoff CX2100-09xx*.



3. Close the dialog with *Finish* and confirm with *Apply*. This will cause the UPS service to adopt the settings and start the UPS service.

4. Then, on the *BECKHOFF UPS configuration dialog*, go to *Alarm configuration*.



5. Activate the following options (not absolutely essential).
   Activate all notifications: This option will cause the operating system to send messages to the user whenever the power fails (not available under NT 4.0).
   Critical alarm: The alarm is triggered once the battery voltage has fallen to a certain level or once battery operation has exceeded a certain time limit. This parameter must be set to "0" for the CX20x0 system. It can be set to 1 minute in exceptional cases.
   Execute the following program at an alarm: This option can be used to execute an application when an alarm is raised (only available under NT 4.0 if the Microsoft Task Scheduler is installed).
   Activate the following options:
   Minutes remaining for battery operation before critical alarm: This option can be used to specify the battery operation time in minutes until the *Critical alarm* is triggered. The shutdown of the operating system is only initiated once the alarm has been triggered. This option should be selected in order to protect the battery. Set the *"Battery time"* to 2 minutes, for example. The permitted values lie between 0 and 720 minutes. The system will be shut down once this time has elapsed after a power failure. This option corresponds to the same option that can be set in the standard UPS dialog, with the difference that the shorter times of 0 and 1 minute can also be set.
   Switch off UPS: If this option is selected, the UPS will switch off its own outputs after shutdown in order to save the battery. This option also corresponds to the same option that can be set via the standard UPS dialog. Default: Activated!.
   Delay time for switching off the UPS [s]: After this delay the system should have shut down, and the UPS switches its outputs off in order to save the battery. Must be set to "0" for the CX2100-09xx.
6. Close the dialog with OK, and then click *Apply*.

⇨ The configuration is thus completed.

6.5 UPS functions

6.5.1 BECKHOFF UPS Configuration dialog

6.5.1.1 Beckhoff UPS configuration dialog

Following installation under **Win2K/XP/XPe/WES 7** the UPS configuration dialog will be found as an additional tab under *Control Panel -> Power Options*.



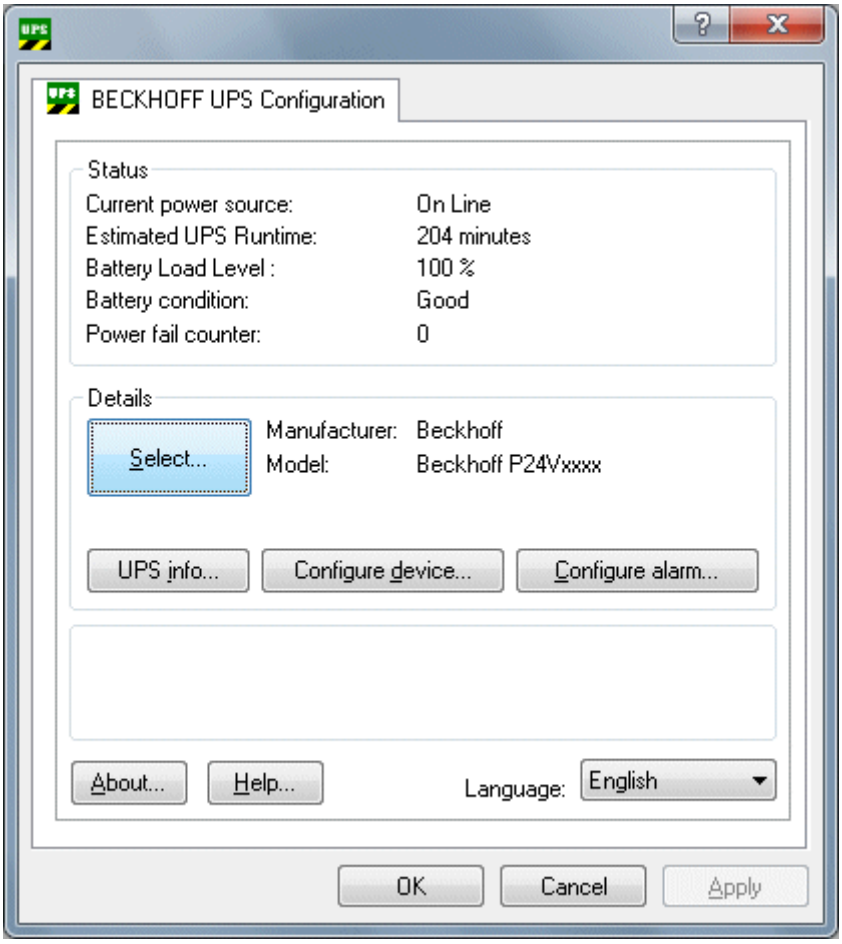
Under **NT4.0** UPS configuration dialog can be called via the shortcut under *Control Panel -> BECKHOFF UPS Configuration*.



Under **Windows Vista or Windows 7** you can reach the UPS configuration dialog via the link in the Start menu: *Start->All Programs->BECKHOFF->UPS Software Components->UPS Configuration*

The UPS devices that are connected to the serial interface can in fact be fully configured via the standard dialog under *Control Panel -> Power Options -> UPS*. The setting facilities are adequate for an office PC, but it is not always possible to achieve an optimum configuration through this dialog for an Industrial PC with a UPS. An additional dialog is therefore made available under *Control Panel -> Power Options*: *BECKHOFF UPS Configuration*.
This dialog can be used, for instance, to make device-specific settings on the CP903x card, or to carry out a firmware update for the P24Vxxxx UPS. The supplementary dialog also allows the maximum *"time on battery"* to be set to < 2 minutes, and for the delay time for switching off the UPS to be configured.

The UPS configuration settings can be made solely by a user with administrator rights. The corresponding dialogs are disabled for other users.



Language selection: From UPS software version >= 2.0.0.9 the language of the UPS dialogs can be selected at runtime. The language settings are permanently stored for all users if they have been changed by a user with administrator rights. All other users can change the language, but the setting is not permanently saved.

The *'User Default'* language setting has a special meaning. It is recommended to use this setting on an operating system with a Multilingual User Interface (MUI). The UPS dialog then appears automatically in the language that you have set under Control Panel -> Regional Settings for the UI dialogs.

If a language is not supported by the Beckhoff UPS dialog, the dialog appears in US English.

Power-fail counter: From UPS software version >= 3.0.0.6. The counter is set to zero on starting the UPS service and counts the number of power failures detected by the UPS service.

Select...

UPS info…

Configure device...

Configure alarm...

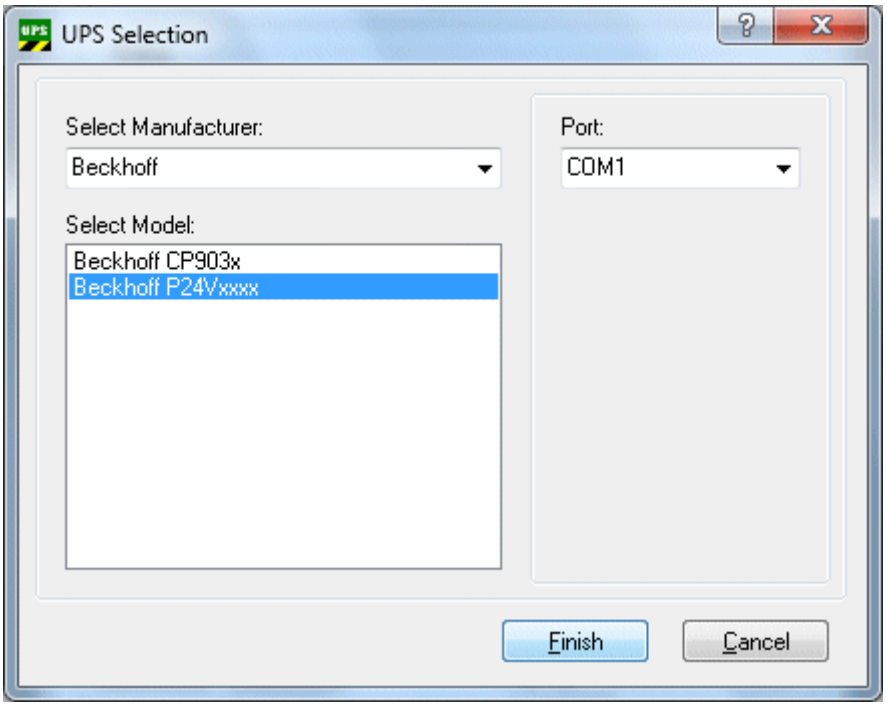
Expanded...

About...

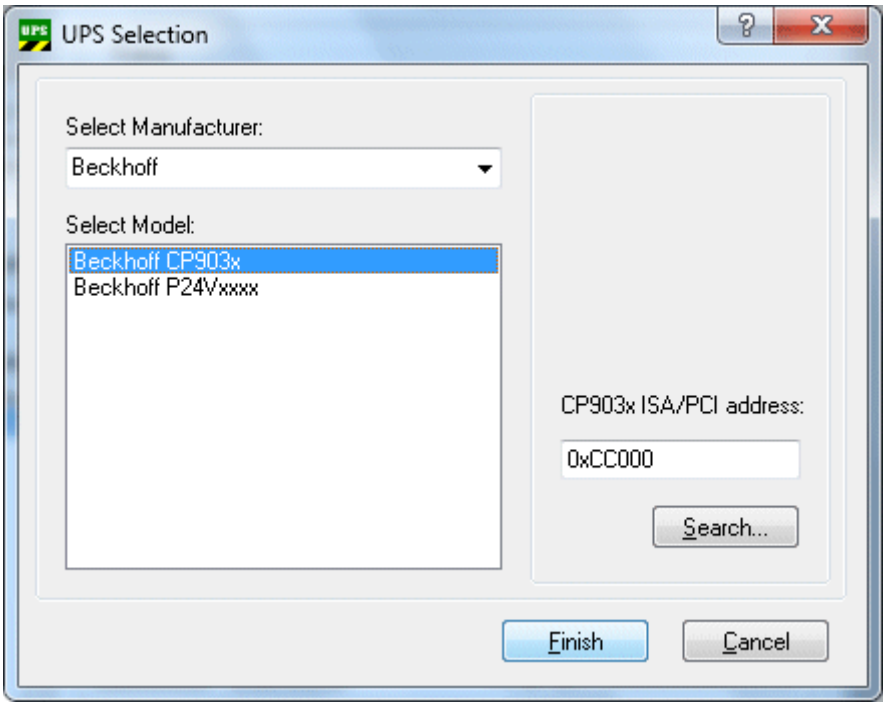
Help...

6.5.1.2 Select dialog

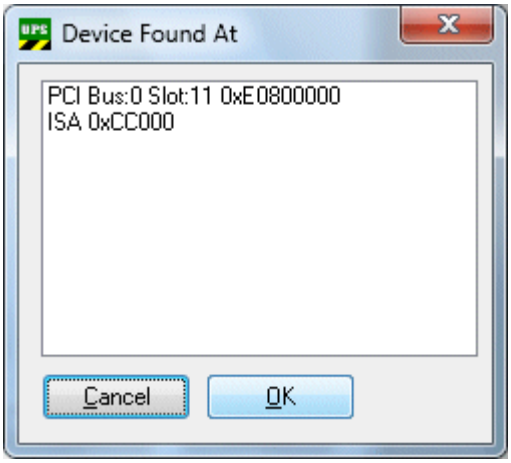
This dialog can be used to select the UPS model.



The correct ISA/PCI address must be configured for the CP903x UPS:



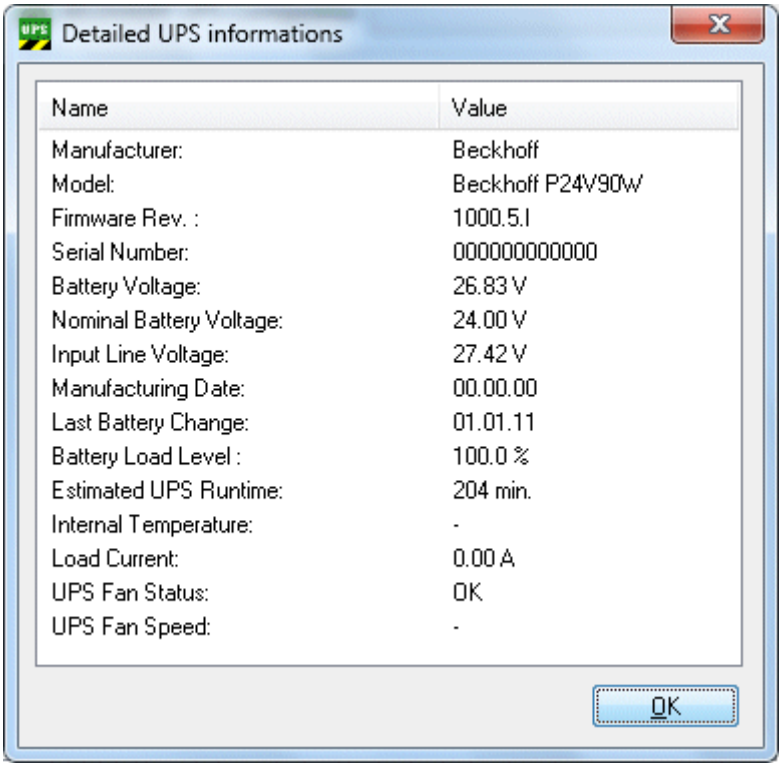
Search: If you have one of the integrated 24V UPS devices on the CP903x card and want to configure it for UPS service you can use the *Search* button to find the correct address of the CP903x ISA or PCI card.



Several CP903x cards can be fitted in one PC, but the UPS is only physically linked to one of them. The Search button can be used to look for all the CP903x cards. The appropriate card must then be selected.

6.5.1.3 UPS info. dialog

The detailed UPS information is displayed in this dialog.



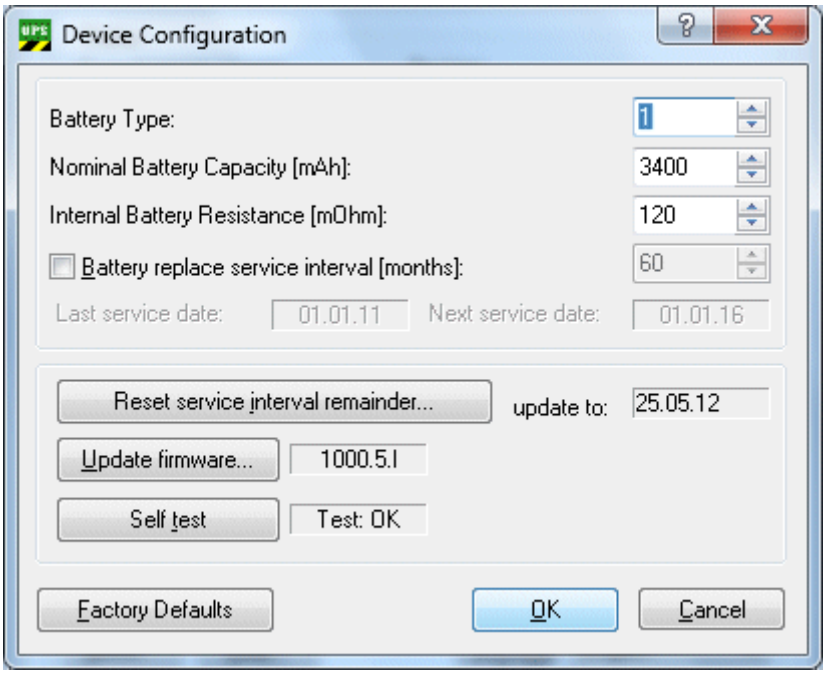
UPS fan status: Only available with Beckhoff P24Vxxxx with firmware version >= 45.1.I.

The nominal speed of the fan is ~3000 RPM or ~10000 RPM.

UPS fan speed: Only available with Beckhoff P24Vxxxx with firmware version >= 45.1.I.

6.5.1.4 Device configuration dialog

Dialog with device-specific settings.



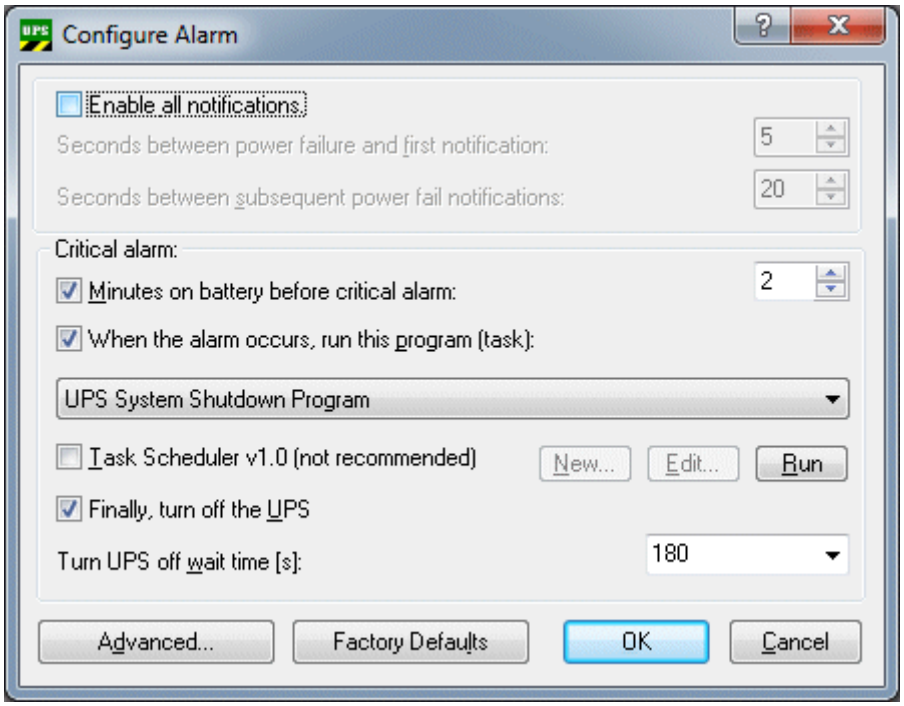
Setting/command	Area	Default value	Description
Battery type	0..99	1	Only specific for the Beckhoff P24Vxxxx UPS **from firmware version >= 24.1.l** and required, for example, in order to calculate the remaining battery capacity in battery mode.
Nominal battery capacity	0..99900 [mAh]	3400	Only specific for the Beckhoff P24Vxxxx UPS **from firmware version >= 24.1.l** and required, for example, in order to calculate the remaining battery capacity in battery mode.
Battery internal resistance	0 - 999 [mOhm]	120	Only specific for the Beckhoff P24Vxxxx UPS **from firmware version >= 24.1.l** and required, for example, in order to calculate the remaining battery capacity in battery mode.
Battery change interval service	0 - 480 [months]	60 (5 years) and checkbox not checked	Only for the Beckhoff P24Vxxxx UPS from **UPS software v3.0.0.8** or higher. An interval service can be configured for this on whose expiry battery change warnings are written into the Windows event log. Use the checkbox to activate or deactivate the function. The number of months before the first warning must additionally be configured in the Edit field. The function is only available if the date of the last battery change and the Windows system time (in the taskbar) have also been correctly set/configured. The UPS service compares the date of the last battery change + interval service with the system date. If the system date is exceeded, a warning is written into the event log. The warning does not provide any information about the actual battery state and can only be used as a reminder to check the battery state/age.
Last service: 01.01.11*	-	-	Displays the date of the last battery change (last service was on January 1, 2011).
Next service: 01.01.16*	-	-	Shows the prospective date of the next battery change (next service is due on January 1, 2016).
Reset interval service message…	-	-	Only for the Beckhoff P24Vxxxx and some APC devices. Updates the date of the last battery change and resets the interval service message. The date is stored in the UPS's EEPROM, and can be examined in the UPS information [▶ 43] dialog.
set to: 25.05.12*	-	-	Displays the date which is suggested when resetting the service message. The last battery change/service is updated to this date (the current date is May 25, 2012).
Firmware update...	-	-	Only for the Beckhoff P24Vxxxx **from firmware version: >= 21.1.l.** Starts a firmware update. Only starts a firmware update if you actually have a suitable new firmware file.
Self-test	-	-	Only for the Beckhoff P24Vxxxx and some APC devices. Executes a self-test and displays the result: • "OK" - Test successful, the battery is OK; • "BT" failed due to insufficient battery capacity or no battery is present\connected at all; • "NG" - Failed as a result of overload; • "NA" - Test function does not exist;

Setting/command	Area	Default value	Description
Factory settings	-	-	Available from **UPS software v3.0.0.8** and higher. Restores the factory settings (default values).
OK	-	-	Saves the settings and closes the dialog. Please do not forget to confirm the settings in the Beckhoff UPS Configuration dialog.
Cancel	-	-	Discards all editable changes.

*) Example values

6.5.1.5 Alarm configuration dialog

Displays the dialog with the settings governing how this system will behave in the event of a power failure. The settings on this dialog largely correspond to the same settings on the standard *Power Options -> UPS -> Configure...* dialog.



Setting/command	Area	Default value	Description	UPS software version
Activate all notifications	Deactivated or activated	Deactivated (checkbox not checked)	This option can be used to instruct the operating system to send messages to the user in case of Power failure.	
Seconds between the power failure and the first notification	0..120 [s]	5	The delay after which the first "power fail" message will be sent.	v2.0.0.15
Seconds between further power failure notifications	0..300 [s]	20	The time that elapses before additional messages are sent to the user.	v2.0.0.15
Critical alarm	-	-	The alarm is triggered once the battery voltage has fallen to a certain level or once battery operation has exceeded a certain time limit.	-
Minutes remaining for battery operation before critical alarm:	0..720 [min]	2	If you have selected this option, the UPS service will initiate the critical alarm after the set time and will shut down the PC. The critical alarm may, however, be issued earlier if the battery capacity is exhausted. If the value is set to 0, the PC will be shut down immediately in the event of a power failure, and the OS shutdown can no longer be stopped.	-
On alarm, execute the following program (task)*	Deactivated or activated	Deactivated (checkbox not checked)	With this option an application can be executed on alarm, but before the actual shutdown (Task Scheduler shutdown task). The Task Scheduler tasks found are displayed in the list below after selecting this option. Subsequently, a task must be selected from the list. The default task with the name "UPS System Shutdown Program" is automatically selected if it exists and if no other task has been configured beforehand.	-

Setting/command	Area	Default value	Description	UPS software version
Combo box (task list)	Task Scheduler tasks	"UPS System Shutdown Program"	Please do not forget to set the user name and his password during the configuration of the shutdown task. The shutdown task is managed by the Windows Task Scheduler and can only be executed in a certain user context. The configured user may require special access rights to the system, drives, etc. If the configured user name/password corresponds to the logged-in user, the shutdown task is interactively executed (visible in the foreground). "NT AUTHORITY\SYSTEM" can be also entered as the system user account (system account, a password is not necessary in this case). The system user account has full access to the local computer, but no access rights to other systems in the network or mapped network drives. Please do not use dialog applications that require user inputs. These would only obstruct the shutdown process. The application should terminate itself at the latest after 30 seconds. Further information can be found in the Windows Task Scheduler documentation.	v3.0.0.10
New...	-	"UPS System Shutdown Program"	Creates a new Task Scheduler task with a specified default name: "UPS System Shutdown Program". This function is only available under XP and also only if the task with the default name does not yet exist in the list of tasks. Under Windows Vista and 7 please use the Task Scheduler dialog in the MMC (Microsoft Management Console) in order to create a new task.	v3.0.0.10
Edit...	-	"UPS System Shutdown Program"	Configures the Task Scheduler tasks which should be executed by the UPS service before the initialization of the operation system shutdown. This function is only available under XP. Under Windows Vista and 7 please use the Task Scheduler dialog in the MMC (Microsoft Management Console) in order to configure a new task.	v3.0.0.10

Setting/command	Area	Default value	Description	UPS software version
Run...	-	-	Starts the selected Task Scheduler task for test purposes. The task is stopped automatically after max. 30 seconds. This function is only available under XP. Under Windows Vista and 7 please use the Task Scheduler dialog in the MMC (Microsoft Management Console) in order to test or start the task.	v3.0.0.10
Task Scheduler v1.0 (not recommended)	Deactivated or activated	Deactivated (checkbox not checked)	Activates/forces the use of the XP Task Scheduler v1.0 interface on Windows Vista or 7 systems (not recommended). The Task Schedulers v1.0 offers only limited functionalities under Windows Vista and 7.	v3.0.0.10
Switch off UPS	Deactivated or activated	Activated (checkbox checked)	If you have selected this option, the UPS will switch the outputs off after the PC has been shut down, in order to save the battery charge (default: activated).	-
Delay time for switching off the UPS [s]:	Hardware-dependent; see table below	180	The PC must have properly shut down within this time. An internal timer in the UPS measures the time from when the OS began to shut down. Once this time has elapsed, the UPS switches off its outputs in order to save battery charge. Make sure that you have not selected too small a value. The available delay times differ from device to device and are read from the device and displayed in the combo box. The UPS service must be configured and started up with the appropriate UPS model to make this possible.	v1.0.0.48
Advanced...	-	-	Advanced shutdown or end-of-session options for systems without soft power-off functionality (S5) (e.g. NT4). See also under: Advanced Settings [▶ 51]. The option is not available in systems with the soft power-off support (deactivated).	v2.0.0.12
Factory settings	-	-	All settings are reset to their default values.	-
OK	-	-	Saves the settings and closes the dialog. Please do not forget to confirm the settings in the Beckhoff UPS Configuration dialog.	-
Cancel	-	-	Discards all editable changes and closes the dialog.	-

*) Under NT4 this option is only available if you have installed the Microsoft Windows Task Scheduler (under IE4 you select the *Task Scheduler* under *Additional Explorer Enhancements*, and under IE5 you select the *Offline Browsing Pack*).

The table provides a brief summary of the various delay times for a few UPS models.

UPS model	Beckhoff P24Vxxxx UPS	Beckhoff 24V UPS on the CP903x card	APC Back-UPS Pro 280	APC Smart-UPS 420
Available delay times in [s]	20, 30*, 45*, 60, 90, 180, 300, 600 *from firmware version >=28.1.I	0, 2, 5, 10, 15, 25, 40, 60, 90, 120, 150, 180, 210, 240, 270, 600	20, 180, 300, 600	60, 180, 300, 600

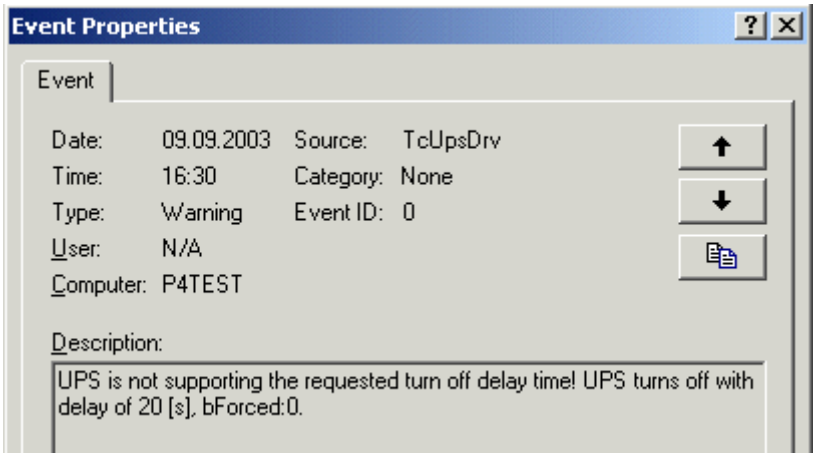
Important instructions!

The delay time configured in the dialog is checked again in the UPS driver shortly before the OS shutdown. If a value that is not supported is found, the next higher value is automatically sent to the UPS.

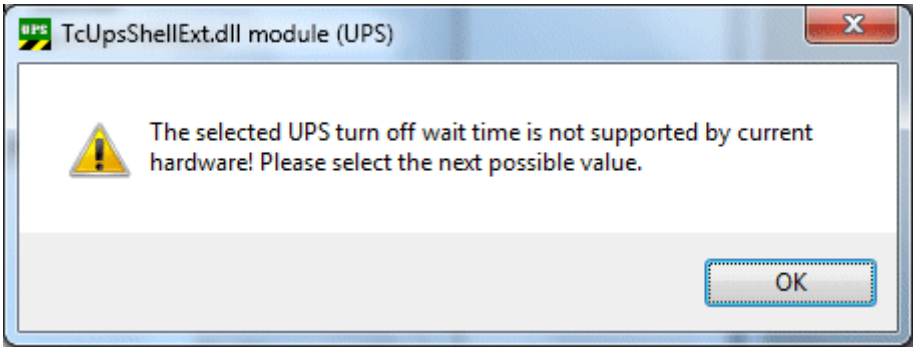
Example:

Suppose you have replaced an old Back-UPS Pro 280 with a Smart UPS 420, and that a delay time of 20 s had previously been configured in the dialog. The new UPS will then automatically be switched off after a delay time of 60 s.

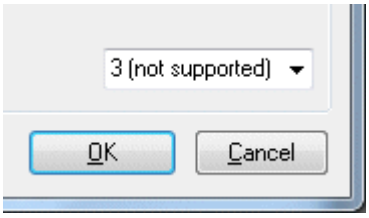
At the same time the UPS driver will write a warning into the windows event log (under Application).



As from **UPS software version v1.0.0.48** the following warning will be displayed if an unsupported delay time is found when the alarm configuration dialog is opened:



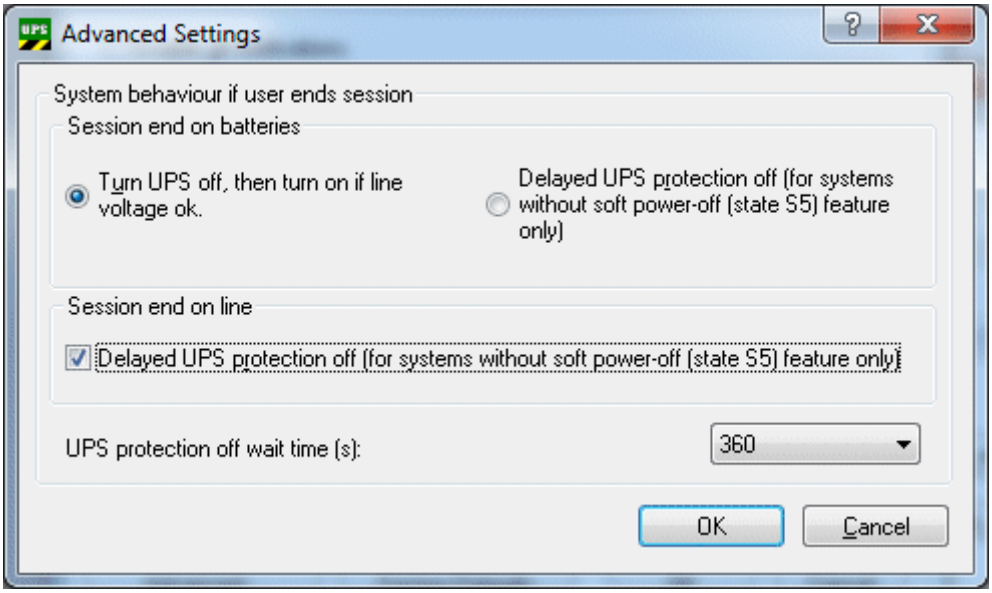
The unsupported delay time is placed into the ComboBox as (not supported):



6.5.1.5.1 Advanced Settings dialog

The following settings are only available in systems without Soft-Power-Off support (S5 state) (e.g. NT4 systems). A PC system with Soft-Power-Off support can switch off the power supply after shutdown. The end of a session includes a shutdown or restart of the PC, i.e. all settings relating to the end of the session not only apply to the shutdown, but are retained when the PC is restarted.

Once a mains-operated NT4 system has been shut down, it cannot distinguish between deliberate and non-deliberate power failure. This means the UPS software and the hardware cannot distinguish between a genuine power failure and the operator operating the main switch (in order to switch off the system completely). The UPS merely detects a power failure and switches to battery operation. If the operator has switched off the main switch, the PC will remain on battery power, eventually draining the battery.
In order to prevent this, the Beckhoff P24Vxxxx UPS features an option to deactivate UPS protection after a certain delay time. During the delay time, the PC is protected against possible power failure. The PC will remain on until the external power supply is switched off.



System behavior in the event of a session being ended by the user: The associated settings determine the system behavior if the end of a session was not initiated by the UPS service, but by the user or the application (the user may have selected shutdown or restart via the start button).

End of session from battery: These options determine the system behavior if the PC was running on battery at the time (start of the end of a session).

End of session from mains voltage: These options determine the system behavior if the PC was running on mains voltage at the time (when the end of a session was initiated).

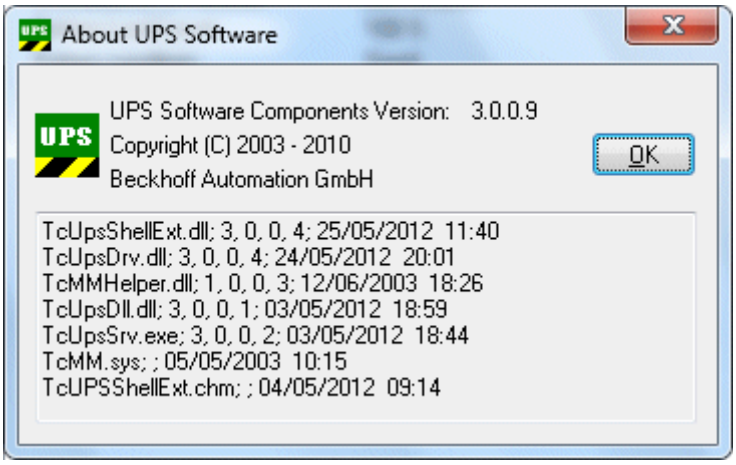
UPS off and on again if mains voltage OK: If this option is selected, the UPS (and the PC) switches off once the delay time has elapsed and immediately on again once the external power supply is available again (power ON after power fail). **This is the default behavior** for all systems, including systems with Soft-Power-Off support. The delay time for switching off the UPS has to be configured via the Alarm configuration dialog [▶ 46]. If this option is selected and the PC is battery-operated, the PCs must not be restarted! Otherwise the PC may be switched off during the start-up phase!

Delayed UPS protection switch-off (only for systems without Soft-Power-Off support (State S5)): If this option is selected, UPS protection is deactivated after a configurable delay time, in order to enable the PC and the UPS to be switched off (e.g. via the main switch). This option is **only supported by Beckhoff P24Vxxxx UPS and UPS firmware version >= 33.1.I.** In other models this option is deactivated.

Delay time for switching off UPS protection (s): With shorter times, the PC (and the UPS) can be switched off more quickly after a shutdown. However, during a restart the PC may not be fully protected against voltage failure. With longer times and shutdown, it takes longer for the PC (and the UPS) to switch off. On the other hand, during a restart the PC is protected during the complete start-up phase. During a restart, UPS protection is activated before the delay time has elapsed, once the UPS service has resumed communication with the UPS. Default: 360 seconds.

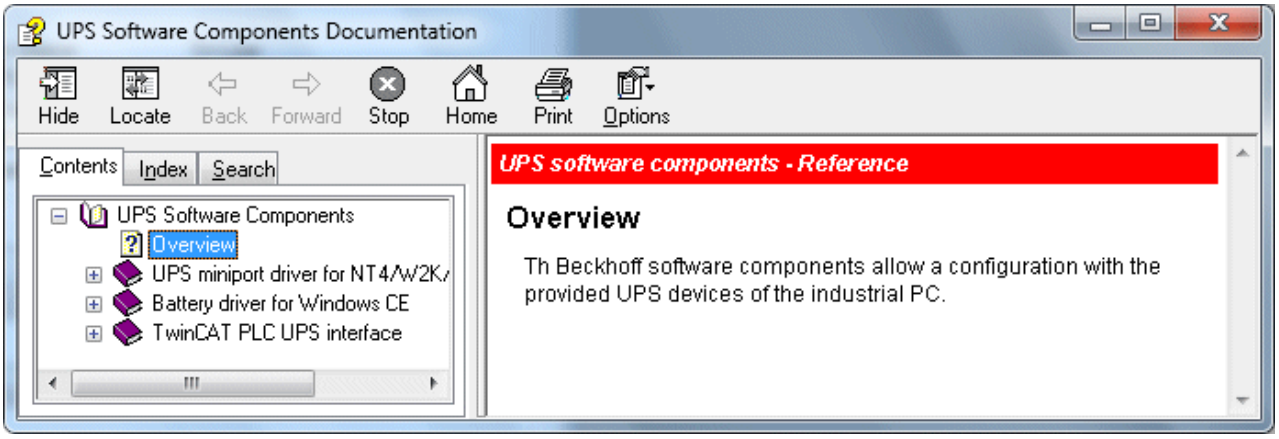
6.5.1.6 About dialog

This dialog displays the version information for the UPS software components.



6.5.1.7 Help dialog

Calling the help dialog:

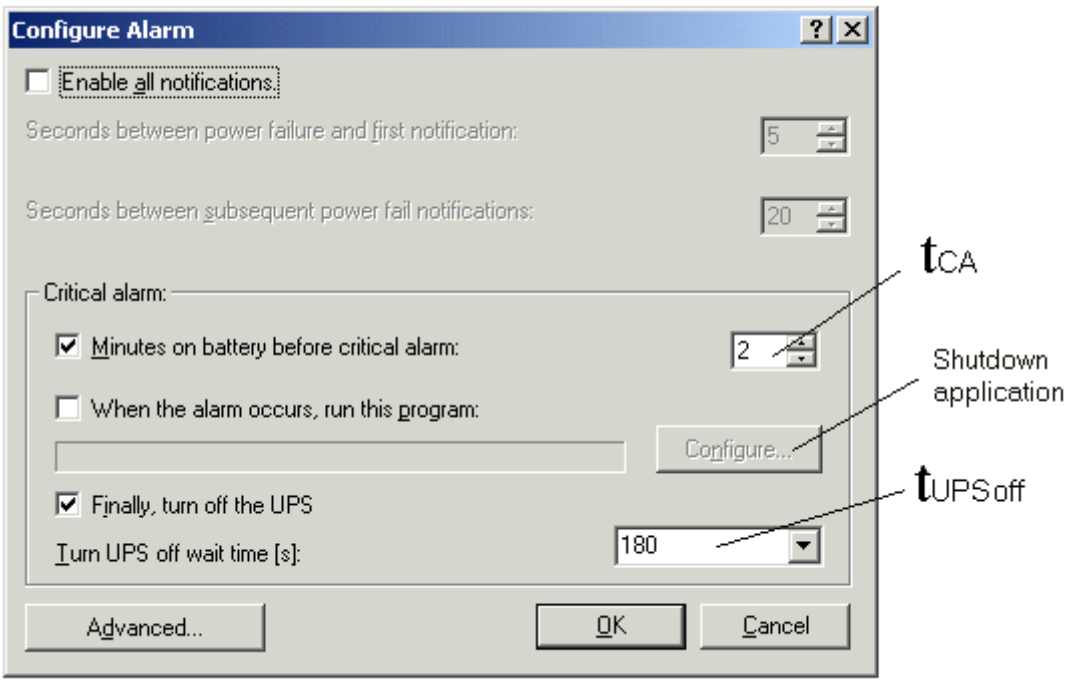


6.5.2 System behavior: Beckhoff miniport driver for the Windows UPS service

Definitions:

Short power failure: tBatt <tCA

Long power failure: tBatt >=tCA

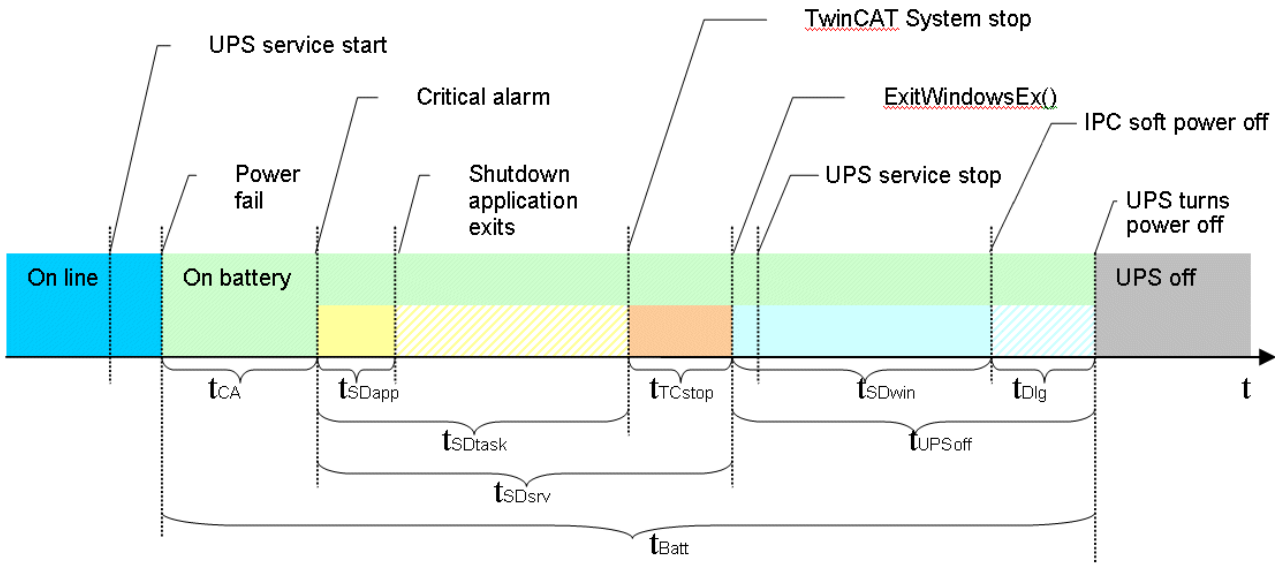


Value	Description	Features
tBatt	Time during which the system is operated via the battery.	Variable, depending on the duration of the power failure. If tBatt >= tCA the UPS service irrevocably starts shutting down the system.
tCA	Maximum time on battery voltage before critical alarm. Once this time has elapsed the UPS service irrevocably starts shutting down the system.	Configurable in minutes via the Beckhoff UPS configuration dialog. If tCA = 0 the UPS service immediately starts shutting down the system.
tSDtask	A time window provided by the UPS service for a shutdown application (shutdown task).	Not configurable, fixed and limited to a maximum of 30 seconds. • NT4: tSDtask = 0 if no shutdown application was configured and tSDtask = tSDapp if a shutdown application was configured. • All other operating systems: tSDtask always requires 30 seconds.
tSDapp	Time actually required by the shutdown application (shutdown task).	Variable, depends on the features of the application. Limited to a maximum of 30 seconds. After 30 seconds the shutdown is irrevocably continued. tSDapp should always be < maximum of tSDtask.
tTCstop	This time is required for stopping the TwinCAT system. During this time the UPS service stops all TwinCAT servers.	Variable, depends on the number of configured TwinCAT servers. Limited to a maximum of 45 seconds. Shutdown continues irrevocably after 45 seconds. tTCstop = 0 if TwinCAT is not installed or has already been stopped beforehand.
tUPSoff	Delay time for switching off the UPS. The actual shutdown of the operating system starts once the UPS service has completed all internal shutdown tasks. Once this time has started the operating system takes over control and continues with the shutdown (window applications and services including the UPS services are closed and the system is shut down completely). Once this time has elapsed the UPS irrevocably switches off the outputs and the IPC in order to save battery capacity.	Configurable via the Beckhoff UPS configuration dialog. The available values are hardware-specific. tUPSoff should always be >tSDwin.
tSDsrv	Time required by the UPS service for shutting down internal tasks.	tSDsrv =tSDtask +tTCstop
tSDwin	Time required by the operating system for a shutdown.	Variable, depends on the number of running applications that have to be closed.
tDlg	For systems without soft power-off functionality (e.g. NT4): For systems with soft power-off functionality (e.g. XP):	Variable, depends on the operating system used, the number of running applications, the motherboard and the UPS hardware: tDlg = tUPSoff - tSDwintDlg should always be > 0. You can only influence this value by the choice of tUPSoff. For systems without soft power-off functionality the dialog should be visible at least for a short time before the UPS switches off the IPC. For systems with APC-UPS and soft power-off functionality the IPC should switch off first, followed by the UPS.

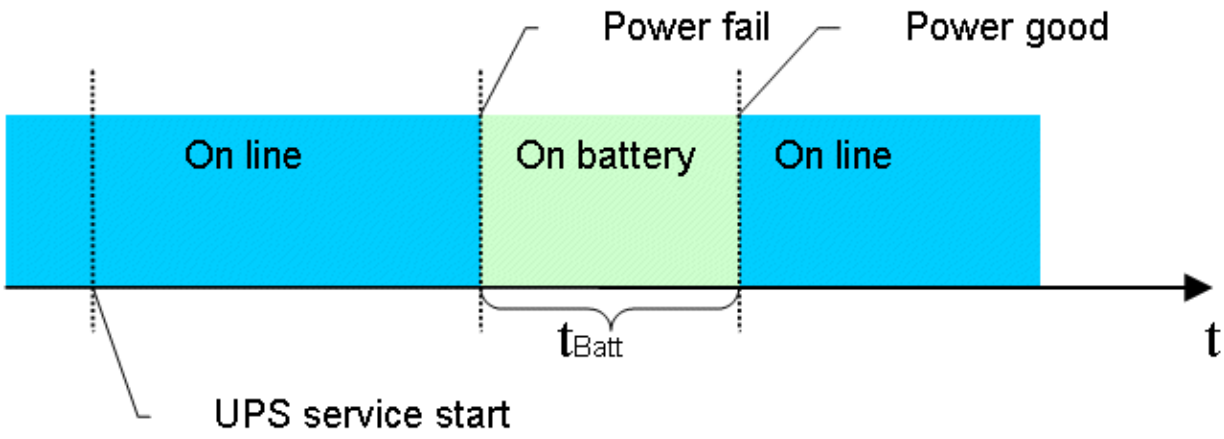
Value	Description	Features
tBoot	Time required by the operating system during the boot process until the UPS service is started.	Variable, depends on the number of applications and services that have to be started.

Long power failure during operation (tBatt >= tCA)

The UPS service has been started and is active. During a long power failure the UPS service irrevocably starts shutting down the system.

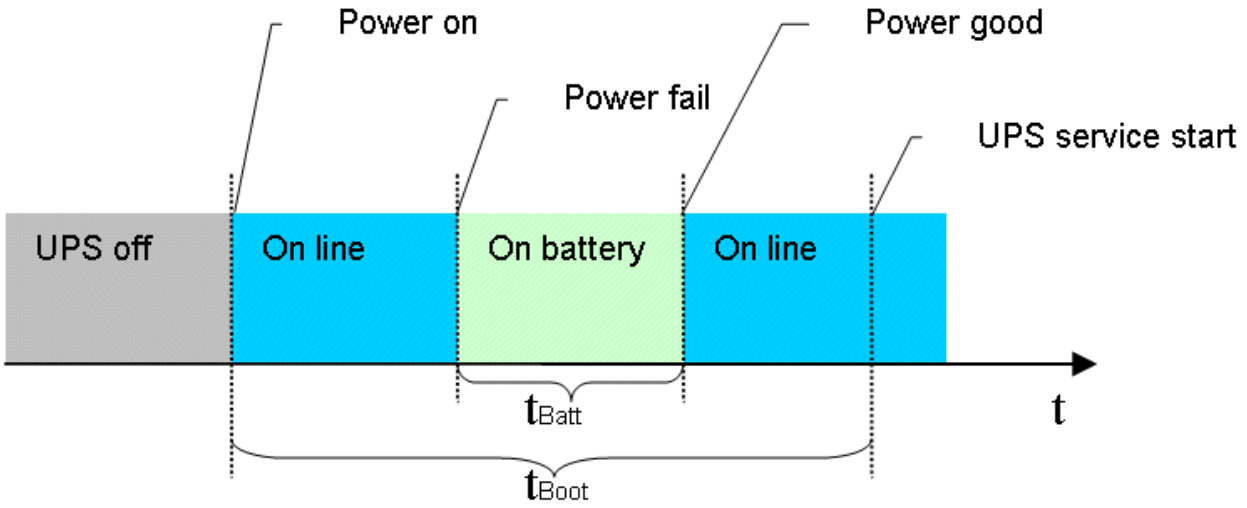


Short power failures during operation (tBatt < tCA)



The UPS service has been started and is active. Short power failures are bridged by the UPS. A shutdown through the UPS service is not initiated.

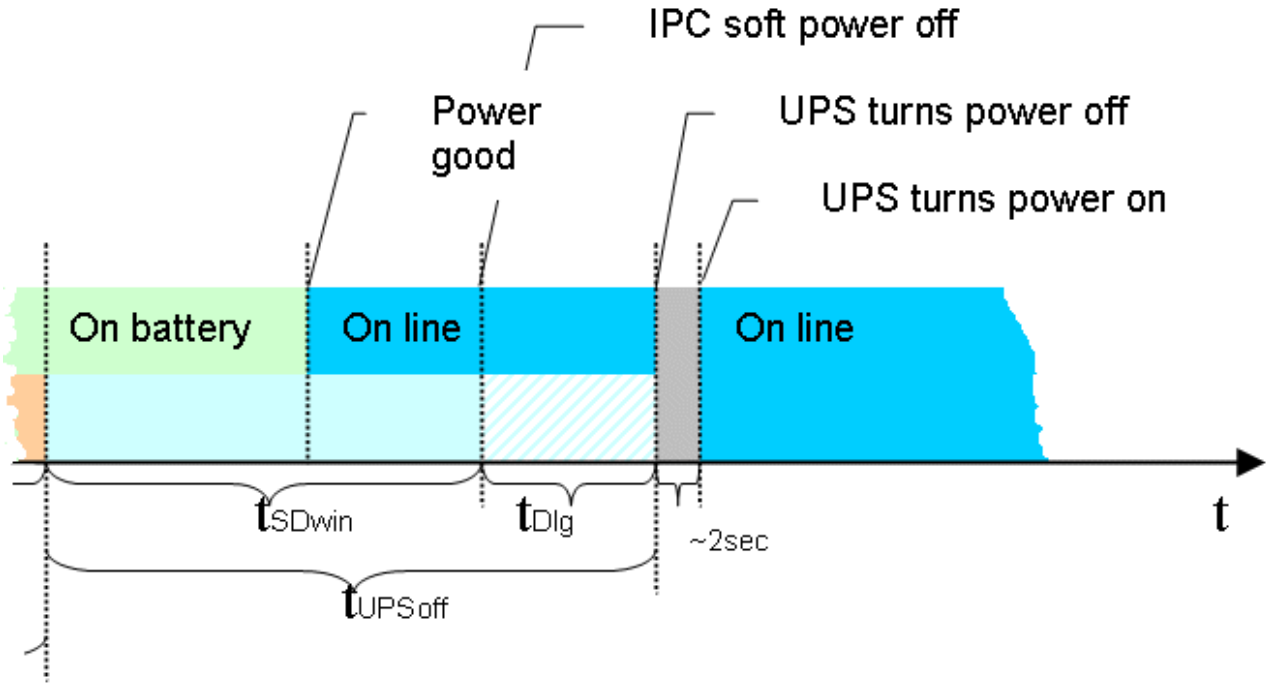
Power failure during the boot process



The UPS service is not yet active at this time. The UPS automatically switches to battery operation, thus bridging the power failure. The PC is booted up in battery mode. During a prolonged power failure the UPS service takes over control after the start and starts shutting down the system.

Restoration of supply and repeated power failures during UPS shutdown

The following diagram shows a case in which the UPS service initiates a shutdown and the supply is restored during the shutdown.



Once the UPS service has initiated the shutdown this process cannot be stopped and must be completed. Repeated power failures during the shutdown are bridged by the UPS. In order to enable the IPC to restart the external power supply is interrupted briefly (a few seconds).

6.5.3 UPS information in the Windows Registry

The UPS service communicates with the Beckhoff UPS driver via the Windows Registry. You can access this information in read mode. In order to configure the UPS (write), please use the "Beckhoff UPS Configuration dialog". Caution is required if you wish to directly change the UPS configuration in the Windows Registry (write).

Status information

```
HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services\UPS\Status
```

The keys under here are continuously updated by the UPS driver whenever the status of the UPS changes.

Notice:

Not every UPS device can supply all the status information. Overview of the status information supported [▶ 64].

Name	Type	Description	Default value
Ba**tteryCapacity**	REG_DWORD	Remaining UPS battery capacity in percent. This element can adopt a value between **0** and **100** (the value displayed is rounded up).	0
BatteryStatus	REG_DWORD	Current status of the UPS battery. This element can adopt the following values: • 0 := the battery status is unknown; • 1 := the battery status is OK; • 2 := the battery must be exchanged;	0
CommStatus	REG_DWORD	Status of communication with the UPS. This element can adopt the following values: • 0 := the communication with the UPS has an unknown status; • 1 := the communication with the UPS is OK; • 2 := the communication with the UPS has been interrupted.	0
FirmwareRev	REG_SZ	Returns the UPS firmware version number as a string.	""
SerialNumber	REG_SZ	Returns the UPS serial number as a string.	""
TotalUPSRuntime	REG_DWORD	The remaining UPS battery time in minutes.	0
UtilityPowerStatus	REG_DWORD	Returns the status of the power supply. This element can adopt the following values: • 0 := the status of the power supply is unknown; • 1 := the power supply is OK; • 2 := a power failure has been detected;	0
TcPowerFailCnt	REG_DWORD	Power failure counter. The counter increments every time a power failure is detected.	0
BatteryReplaceDate	REG_SZ	Date of the last battery change. The date can be set with a command in the Beckhoff UPS Configuration dialog -> Device Configuration…. Implemented in the **UPS software v3.0.0.8** and higher.	""
TcChargeFlags	REG_DWORD	Battery charge and status flags. This element can adopt one or more values (bits) combined: • 0 := unknown status (all bits are zero) • 1 := charge status "High" (bit 0 is set); • 2 := charge status "Low" (bit 1 is set); • 4 := charge status "Critical" (bit 2 is set); • 8 := charge status "Charging" (bit 3 is set); • Bit 4 - 6 reserved; • 128 := No battery connected/found (bit 7 is set); • 256 := UPS fan error (bit 8 is set); • Bit 9 is reserved; • 1024 := Battery change interval service has expired (bit 10 is set). Implemented in the **UPS software v3.0.0.8** and higher. • Bit 11 - 31 reserved;	0

Configuration settings

```
KEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services\UPS\Config
```

The keys below it are used by the UPS service for the configuration of the UPS:

Name	Type	Description	Default value
Vendor	REG_SZ	Name of UPS manufacturer	"(none)"
Model	REG_SZ	UPS model designation	""
RunTaskEnable	REG_DWORD	Activates/deactivates the configuration of the Task Scheduler shutdown task: • 0 := deactivated; • 1 := activated; • other values are not permissible;	0
TaskName	REG_SZ	Name of the Task Scheduler shutdown task. The Beckhoff UPS Configuration dialog generates a shutdown task with the name: "UPS System Shutdown Program".	""
TaskFolder	REG_SZ	Path to the folder containing the Task Scheduler shutdown task. Implemented in the **UPS software v3.0.0.10** and higher. An empty string represents the root folder.	""
TaskCompatibility	REG_DWORD	Task Scheduler v1.0 compatibility settings. Implemented in the **UPS software v3.0.0.10** and higher: • 0 := automatic, uses the latest Task Scheduler interface version (at present v2.0); • 1 := explicitly the Task Scheduler v1.0 is to be used; • 2 := explicitly the Task Scheduler v2.0 is to be used; • other values are not permissible;	0
RunTaskWait	REG_DWORD	Maximum running time (execution time) of the shutdown task in seconds. Following the expiry of this time the shutdown task is stopped and the shutdown is continued. **Implemented in the UPS software v3.0.0.8 and higher and only under Windows Vista, W7, WES 7 (32 and 64-bit). With older operating systems this time cannot be changed and is fixed at 30 seconds.**	30
ShutdownOnBatteryEnable	REG_DWORD	Activates/deactivates the shutdown of the operating system on a critical alarm: • 0 := deactivated; • 1 := activated; • other values are not permissible;	1
ShutdownOnBatteryWait	REG_DWORD	Maximum running time on battery voltage before the critical alarm in minutes. This element can adopt a value of between 0 and 720. Other values are not permissible.	2
NotifyEnable	REG_DWORD	Activates/deactivates the power-fail messages to the logged-in user: • 0 := deactivated; • 1 := activated; • other values are not permissible;	0

Name	Type	Description	Default value
TurnUPSOffEnable	REG_DWORD	Activates/deactivates the switching-off of the UPS output voltage after the shutdown: • 0 := deactivated; • 1 := activated (switches off); • other values are not permissible;	1
TurnUPSOffWait	REG_DWORD	Maximum delay time in seconds for switching off the UPS output voltage after initiating the Windows shutdown. The permissible values can differ from model to model (depending on hardware).	180
BatteryReplaceNotifyEnable	REG_DWORD	Activates/deactivates the logging of the battery change service interval warnings in the Windows event log: **UPS software v3.0.0.8** and higher.	0
BatteryReplaceNotifyWait	REG_DWORD	Delay time in months for the first battery change warning. This element can adopt a value of between 0 and 480 months. Other values are not permissible. Implemented in the **UPS software v3.0.0.8** and higher.	60

Advanced Settings

```
KEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services\UPS
```

Name	Type	Description	Default value
FirstMessageDelay	REG_DWORD	Delay time in seconds for the first power-fail message to the user	5
MessageInterval	REG_DWORD	Delay time in seconds for further power-fail messages to the user.	20

6.6 TwinCAT PLC UPS interface

6.6.1 FB_GetUPSStatus

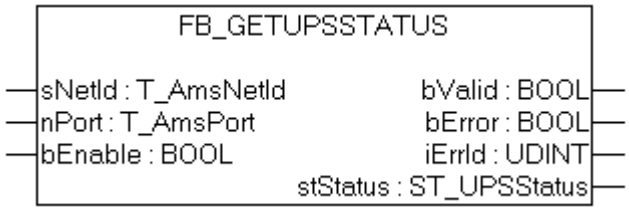


Fig. 8: FB_GetUpsStatus

Requirements under NT4, Win2K, WinXP, WinXP embedded:

- The Beckhoff UPS software components are installed (additional tab under *Control Panel->Energy Options->Beckhoff UPS Configuration*);.
- The UPS has been configurated with the Windows UPS service (*Control Panel->Energy Options->UPS*) or the Beckhoff Shell extension (*Control Panel->Energy Options->Beckhoff UPS Configuration*). Further information about the UPS configuration can be found in the considering documentation.

Requirements under Windows CE:

- Beckhoff CE devices with 24 V UPS service are delivered with a special Beckhoff Battery Driver for Windows CE. The driver is included in the standard CE Image. No further configuration settings are required.

With the FB_GetUPSStatus function block the PLC can read the status of a UPS hardware. The block is level triggered, which means that the status information is only cyclically read while the *bEnable* input is set. To maintain system loading at a low level, the status information is only read approximately every 4.5 s. When the *bValid* output is set, the most recently read data is valid. The most recent read cycle was, in other words, executed without error. If an error occurs, the read cycle is repeated, and the error signal is automatically reset as soon as the cause of the error (e.g. no communication with the UPS) has been corrected.

VAR_INPUT

```
VAR_INPUT
    sNetId     :T_AmsNetId;
    nPort     :T_AmsPort; (* 0 = Windows UPS service / Windows Battery driver *)
bEnable     :BOOL;
END_VAR
```

sNetId: It is possible here to provide the AmsNetId of the TwinCAT computer on which the function to be executed. If it is to be run on the local computer, an empty string can be entered.

nPort: ADS port number. Set this value to zero. Other port numbers are reserved for applications in future.

bEnable: If the input is set, the UPS status is read cyclically.

VAR_OUTPUT

```
VAR_OUTPUT
    bValid     :BOOL;
    bError     :BOOL;
    nErrId     :UDINT;
    stStatus        :ST_UPSStatus;
END_VAR
```

bValid: If this output is set the data in the ST_UPSStatus structure are valid (no error occurs at the last read cycle).

bError: This output is set if an error occurs by execution of the function.

nErrId: Supplies the Ads error number or a command specific error code (table) when *bError output* is set.

stStatus: Structure with the status information [▶ 64] of UPS.

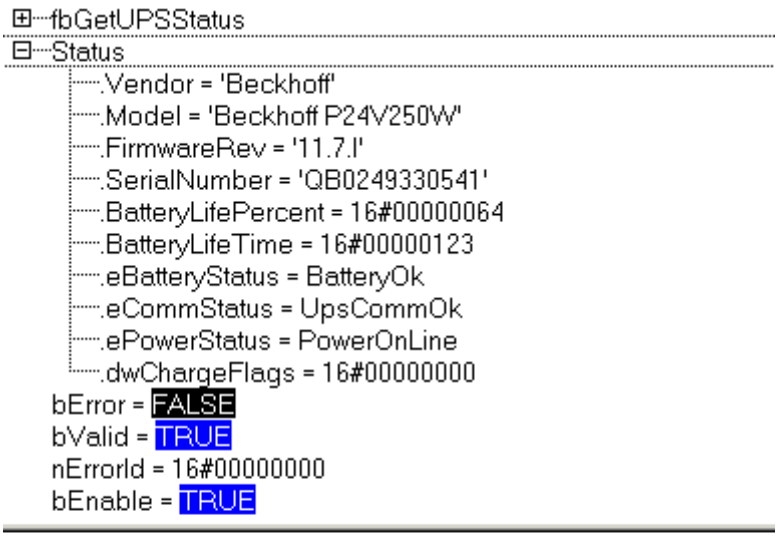
Error codes	Error description
0x0000	no error
0x8001	UPS configuration error. Perhaps the UPS is not configured correctly, or no UPS is configured.
0x8002	Communication error. The communication to the UPS has been interrupted.
0x8003	Error by reading the status data.

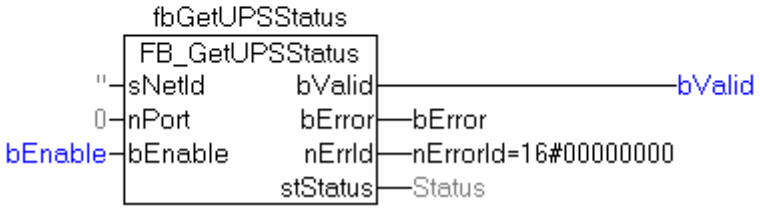
Note:

Not all UPS devices are able to deliver status infomation. Some devices can´t deliver e.g *BatteryLifeTime* or *BatteryReplace*-Status.

Example for a call in FBD

Online data with status information of UPS:





Requirements

Development environment	Target system type	UPS hardware	PLC libraries to include
TwinCAT v2.8.0, Build > 745 TwinCAT v2.9.0, Build > 945	PC (i386)	• Beckhoff P24Vxxxx USV; • Integrated Beckhoff Industrial PC 24V UPS connected to CP903x ISA or PCI card; • With Beckhoff Industrial PC's delivered APC UPS models supporting smart protocol and configured with Windows UPS Service;	TcIoFunctions.Lib (Standard.Lib; TcBase.Lib; TcSystem.Lib; TcUtilities.Lib are included automatically)

6.6.2 ST_UPSStatus

```
TYPE ST_UPSStatus
STRUCT
    Vendor              : STRING;         (* Reports the UPS vendor name as displayable string. *)
Model             : STRING;         (* Reports the UPS model name as displayable string. *)
FirmwareRev         : STRING;     (* Reports the UPS firmware revision as a displayable string. *)
SerialNumber         : STRING;     (* Reports the UPS serial number as a displayable string. *)
BatteryLifePercent     : DWORD;           (* The percent of battery capacity remaining in the UPS,
represented as a value in the range of 0 through 100. *)
BatteryLifeTime             : DWORD;           (* The amount of remaining UPS run time, in minutes.
*)
eBatteryStatus         : E_BatteryStatus;    (* The current status of the UPS batteries. *)
eCommStatus         : E_UpsCommStatus;    (* The status of the communication path to the UPS. *)
ePowerStatus         : E_UpsPowerStatus; (* Reports the status of utility-supplied power into the
UPS. *)
nPowerFailCnt         : DWORD;           (* Power fail counter. Increments every time the UPS
service detects power fail. *)
dwChargeFlags         : DWORD;           (* Most reserved for future use.
        Battery charge status flags. This member can be one or more of the following values.
        0: Unknown status     (all bits set to 0)
        1: High         (bit 0 is set)
        2: Low         (bit 1 is set)
        4: Critical           (bit 2 is set)
         8: Charging           (bit 3 is set)
        - -         (bits 4 - 6 reserved)
        128: No battery     (bit 7 is set)
        256: UPS fan error     (bit 8 is set)
        - -         (bits 9 reserved)
        1024: Service interval message    (bit 10 is set)
        - -         (bits 11 - 31 reserved)
    *)
END_STRUCT
END_TYPE
```

E_UpsPowerStatus [▶ 69] E_UpsCommStatus [▶ 69] E_BatteryStatus [▶ 68]

Not all UPS devices are able to deliver status infomation.

X : The status info is present.

Status info	Beckhoff P24Vxxxx UPS	Beckhoff 24V UPS connected to CP903x ISA or PCI card	APC Back-UPS Pro 280	APC Smart-UPS 420	Description
Vendor	X	X	X	X	Reports the UPS vendor name as displayable string.
Model	X	X	X	X	Reports the UPS model name as displayable string.
FirmwareRev	X	X	X	X	Reports the UPS firmware revision as a displayable string. Empty string if not available.
SerialNumber	X	None	X	X	Reports the UPS serial number as a displayable string. Empty string if not available.
BatteryLifePercent	X	None	X	X	The percent of battery capacity remaining in the UPS, represented as a value in the range of 0 through 100. Zero if not available.
BatteryLifeTime	X	None	X	X	The amount of remaining UPS run time, in minutes. Zero if not available.
eBatteryStatus	• **BatteryUnknownStatus** if no battery found. Only with UPS software version >=2.0.0.6 and UPS firmware >= 25.1.I • **BatteryOk**	• **BatteryUnknownStatus** if no battery found. • **BatteryOk**	X	X	The current status of the UPS batteries.

Status info	Beckhoff P24Vxxxx UPS	Beckhoff 24V UPS connected to CP903x ISA or PCI card	APC Back-UPS Pro 280	APC Smart-UPS 420	Description
eCommStatus	X	X	X	X	The status of the communication path to the UPS.
ePowerStatus	X	X	X	X	Reports the status of utility-supplied power into the UPS.
nPowerFailCnt	X	X	*X	*X	Power fail counter. Increments every time the UPS service detects power fail.

Status info	Beckhoff P24Vxxxx UPS	Beckhoff 24V UPS connected to CP903x ISA or PCI card	APC Back-UPS Pro 280	APC Smart-UPS 420	Description
dwChargeFlags	• **No battery** (bit 7 set) only with UPS software version >=2.0.0.6 and UPS firmware >= 25.1.I The battery existence is checked every minute. • **UPS fan error** (bit 8 set) only with UPS software version >=2.0.0.7 and UPS firmware >=40.1.I The fan status is checked every minute. **New (second) UPS hardware revision required!** • **Battery replace service intervall has expired** (bit 10 is set). Implemented in UPS Software version >= 3.0.0.8;	• **High** (bit 0 set) if battery full loaded. • **Charging** (bit 3 set) • **No battery** (bit 7 set) if no battery found.	None	None	Battery charge status flags.

*) Only available if model "Smart Signaling to any APC UPS & TwinCAT" configured!

Requirements

Development environment	Target system type	UPS hardware	PLC libraries to include
TwinCAT v2.8.0, Build > 745 TwinCAT v2.9.0, Build > 945	PC (i386)	• Beckhoff P24Vxxxx USV; • Integrated Beckhoff Industrial PC 24V UPS connected to CP903x ISA or PCI card; • With Beckhoff Industrial PC's delivered APC UPS models supporting smart protocol and configured with Windows UPS Service;	TcIoFunctions.Lib (Standard.Lib; TcBase.Lib; TcSystem.Lib; TcUtilities.Lib are included automatically)

6.6.3 E_BatteryStatus

```
TYPE E_BatteryStatus :
(
    BatteryUnknownStatus, (*The battery status is unknown.*)
BatteryOk,     (*The batteries are OK.*)
    BatteryReplace     (*The batteries need to be replaced.*)
);
END_TYPE
```

Requirements

Development environment	Target system type	UPS hardware	PLC libraries to include
TwinCAT v2.8.0, Build > 745 TwinCAT v2.9.0, Build > 945	PC (i386)	• Beckhoff P24Vxxxx USV; • Integrated Beckhoff Industrial PC 24V UPS connected to CP903x ISA or PCI card; • With Beckhoff Industrial PC's delivered APC UPS models supporting smart protocol and configured with Windows UPS Service.	TcIoFunctions.Lib (Standard.Lib; TcBase.Lib; TcSystem.Lib; TcUtilities.Lib are included automatically)

6.6.4 E_UpsCommStatus

```
TYPE E_UpsCommStatus :
(
    UpsCommUnknownStatus, (* The communication path to the UPS is unknown. *)
    UpsCommOk,      (* The communication path to the UPS is OK. *)
    UpsCommFailed     (* The communication path to the UPS has failed. *)
);
END_TYPE
```

Requirements

Development environment	Target system type	UPS hardware	PLC libraries to include
TwinCAT v2.8.0, Build > 745 TwinCAT v2.9.0, Build > 945	PC (i386)	• Beckhoff P24Vxxxx USV; • Integrated Beckhoff Industrial PC 24V UPS connected to CP903x ISA or PCI card; • With Beckhoff Industrial PC's delivered APC UPS models supporting smart protocol and configured with Windows UPS Service.	TcIoFunctions.Lib (Standard.Lib; TcBase.Lib; TcSystem.Lib; TcUtilities.Lib are included automatically)

6.6.5 E_UpsPowerStatus

```
TYPE E_UpsPowerStatus :
(
    PowerUnknownStatus, (* The status of power is unknown. *)
    PowerOnLine,      (* Power is OK. *)
    PowerOnBattery      (* A power failure has occurred. *)
);
END_TYPE
```

Requirements

Development environment	Target system type	UPS hardware	PLC libraries to include
TwinCAT v2.8.0, Build > 745 TwinCAT v2.9.0, Build > 945	PC (i386)	• Beckhoff P24Vxxxx USV; • Integrated Beckhoff Industrial PC 24V UPS connected to CP903x ISA or PCI card; • With Beckhoff Industrial PC's delivered APC UPS models supporting smart protocol and configured with Windows UPS Service;	TcIoFunctions.Lib (Standard.Lib; TcBase.Lib; TcSystem.Lib; TcUtilities.Lib are included automatically)

6.7 Battery driver for Windows CE

6.7.1 Battery driver for Windows CE

Beckhoff Industrial PCs with Windows CE and 24 V UPS support are supplied with a special Beckhoff battery driver for Windows CE. In these devices the driver is included in the standard CE image. No further configuration settings are required. The UPS hardware is wired internally with the on-board electronics. Only the external UPS battery pack has to be connected to the device (see description in the device documentation).

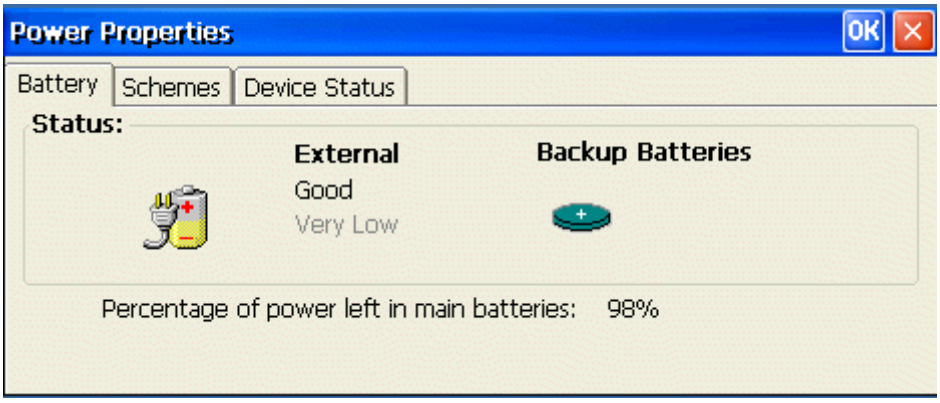
Activating UPS

The UPS is disabled by default under Windows CE and must be activated via the registry entry **Enable_Beckhoff_CX2100-09xx_UPS** under *HardDisk\RegFiles\Samples\UPS*.

Power Options in the Control Panel



The Power Options dialog in the Control Panel shows the status of the external power supply and the remaining battery capacity.



Windows CE API interface for applications

Windows CE applications can access the UPS status information cyclically via the **GetSystemPowerStatusEx2** API function call.

```
DWORD GetSystemPowerStatusEx2(
PSYSTEM_POWER_STATUS_EX2 pSystemPowerStatusEx2,
DWORD dwLen,
BOOL fUpdate
);
```

```
typedef struct _SYSTEM_POWER_STATUS_EX2 {
BYTE ACLineStatus;
BYTE BatteryFlag;
BYTE BatteryLifePercent;
BYTE Reserved1;
DWORD BatteryLifeTime;
DWORD BatteryFullLifeTime;
BYTE Reserved2;
BYTE BackupBatteryFlag;
BYTE BackupBatteryLifePercent;
BYTE Reserved3;
DWORD BackupBatteryLifeTime;
DWORD BackupBatteryFullLifeTime;
DWORD BatteryVoltage;
```

```
DWORD BatteryCurrent;
DWORD BatteryAverageCurrent;
DWORD BatteryAverageInterval;
DWORD BatterymAHourConsumed;
DWORD BatteryTemperature;
DWORD BackupBatteryVoltage;
BYTE BatteryChemistry;
// Add any extra information after the BatteryChemistry member.
} SYSTEM_POWER_STATUS_EX2, *PSYSTEM_POWER_STATUS_EX2, *LPSYSTEM_POWER_STATUS_EX2;
```

Please note that not all parameters are supported by the Beckhoff UPS. The main member variables include:

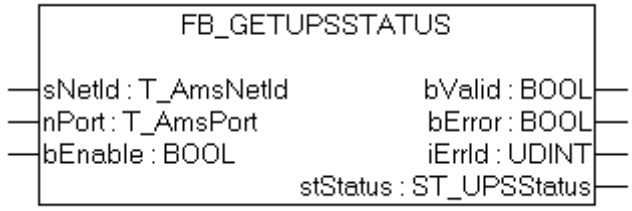
ACLineStatus: Status of the external power supply.

BatteryLifePercent: Battery charge status in percent.

BatteryLifeTime: Remaining battery capacity.

Further information about this API function can be found in the Microsoft online documentation.

UPS interface for TwinCAT PLC



A TwinCAT PLC application can access the UPS status information in read mode via function block FB_GetUPSStatus. Detailed documentation of the function block can be found here: FB_GetUPSStatus [▶ 62].

6.7.2 System behavior: Battery driver for Windows CE

In the event of a power failure the UPS automatically switches to battery operation. The device switches off after it has been running in battery mode for a configurable maximum time.

The maximum time for battery operation is set to **180 seconds** by default. This time is configurable via a Windows registry entry.

Start the Registry Editor and search for the following key:

```
HKEY_LOCAL_MACHINE\Drivers\BuiltIn\Battery\Config\
```

Search for the following value:

```
ShutdownOnBatteryWait REG_DWORD 0x000000b4 (180)
```

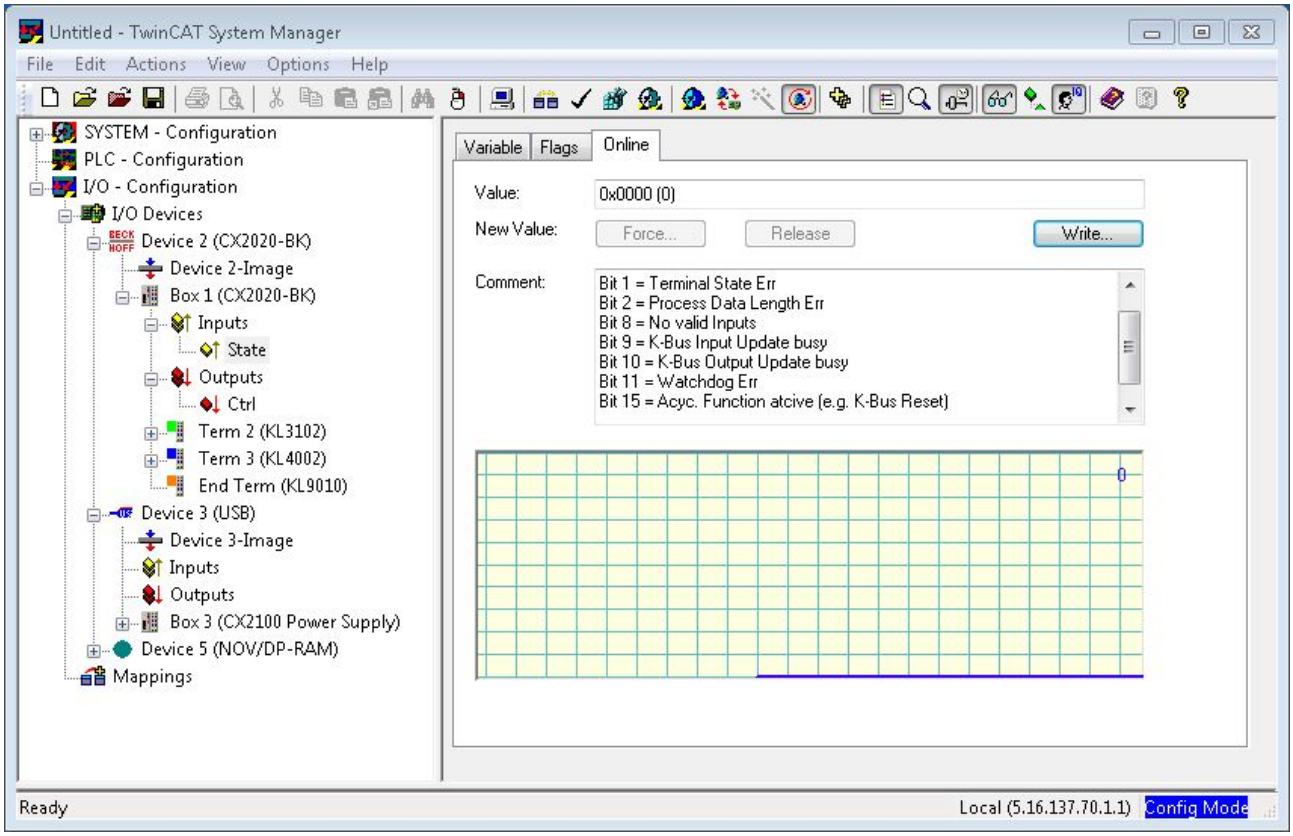
The time is specified in seconds. Permitted range: <0..16200> seconds (corresponds to 270 minutes).

If the value is set, for example, to 0 the shutdown commences immediately in the event of a power failure. The device switches off after a maximum of 20 seconds.

7 Error handling and diagnostics

7.1 Diagnostics in the PLC program

For the analysis of the terminal bus (K-bus) the State register can be accessed via TwinCAT from a PLC program.



The error analysis is presented as an example below.

A signal/variable is essentially required for the error analysis:

- State (indicates the state of the bus: 0 -> no error)

External variables must similarly be created in the PLC program for this:

```
VAR

    k_bus_state AT %IB2 : USINT;

END_VAR
```

The error can then be determined in the PLC program as follows (this is pseudo code, which is not directly executable in this form)

```
....

IF k_bus_state != 0 THEN     (* auf dem K-Bus ist ein Fehler aufgetreten *)

IF k_bus_state.1 = 1 THEN melde Fehler; (* Klemmenzustandsfehler *) END_IF
IF k_bus_state.2 = 1 THEN melde Fehler; (* Prozessdatenlänge ungültig *) END_IF
IF k_bus_state.8 = 1 THEN melde Fehler; (* keine gültigen Eingänge *) END_IF
IF k_bus_state.9 = 1 THEN melde Fehler; (* K_bus Input Update ist aktiv *) END_IF
IF k_bus_state.10 = 1 THEN melde Fehler; (* K_bus Output Update ist aktiv *) END_IF
IF k_bus_state.11 = 1 THEN melde Fehler; (* Watchdog Fehler *) END_IF
IF k_bus_state.15 = 1 THEN melde Fehler; (* Bus ist asynchron *) END_IF
END_CASE

k_bus_request := TRUE;     (* Rücksetzen des Busses, wenn Fehler beseitigt, dann startet der
```

```
Klemmbus wieder *)

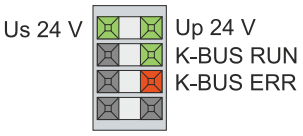
....
```

In order for the controller and the registers to co-operate, they must be linked in the System Manager.

7.2 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 8: 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 9: 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 10: K-BUS ERR LED, fault description and troubleshooting.

Error code	Error code argument	Description	Remedy
Persistent, continuous flashing		EMC problems.	• 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.	• 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.

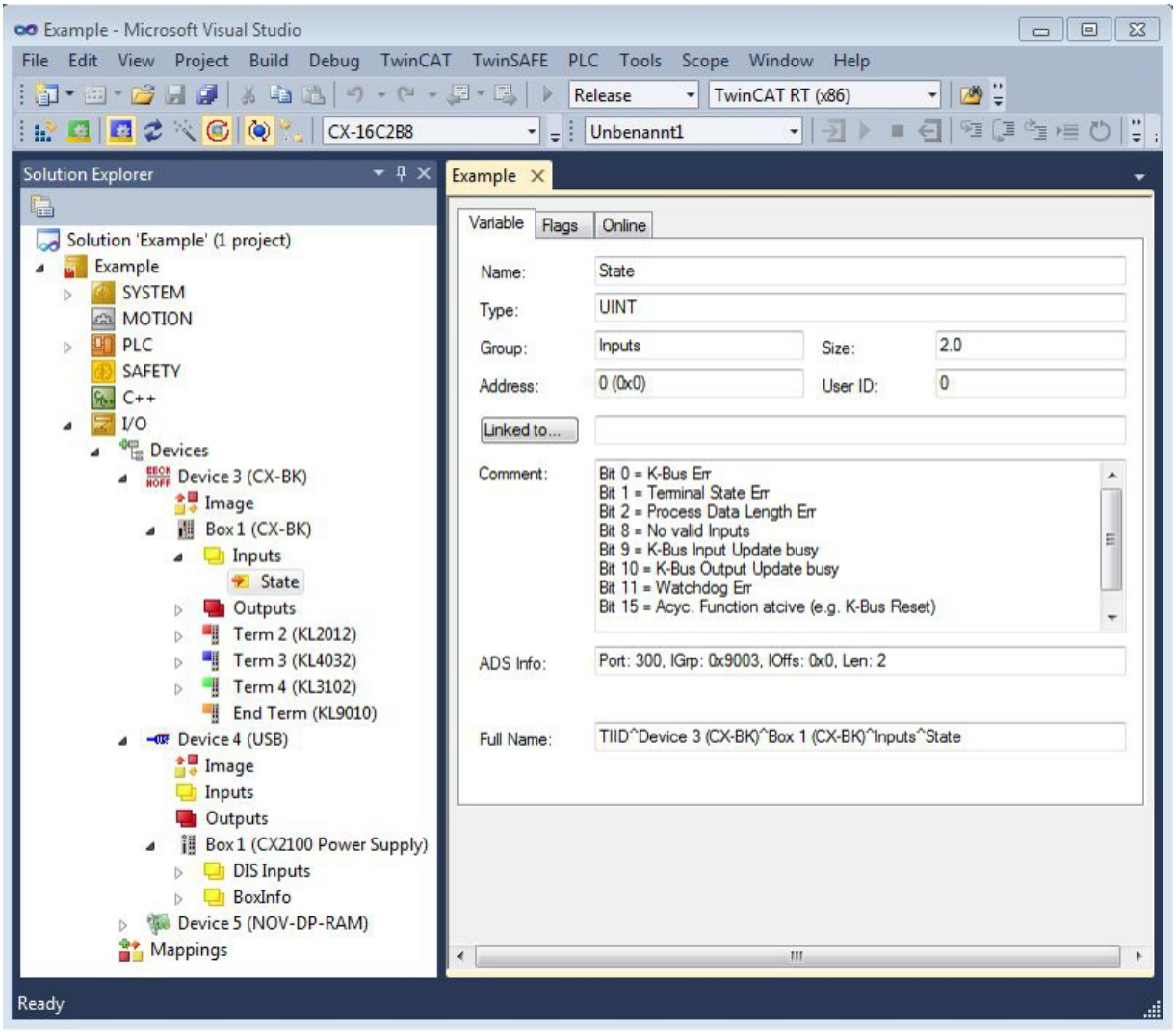


Fig. 9: Status variable for error handling and diagnostics under TwinCAT.

If the value is "0", the K-bus operates synchronous and without error. If the value is <> "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 11: Description of the State variable values.

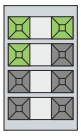
Bit	Description
Bit 0	K-bus error.
Bit 1	Terminal configuration has changed since the start.
Bit 2	Process image lengths do not match.
Bit 8	(still) no valid inputs.
Bit 9	K-bus input update not yet complete.
Bit 10	K-bus output update not yet complete.
Bit 11	Watchdog.
Bit 15	Acyclic K-bus function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

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

7.3 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 12: Diagnostic LEDs in K-Bus mode.

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

8 Decommissioning

8.1 Removing cables

NOTICE

Electrical voltage

If the power supply is switched on during dismounting, this can lead to damage to the Embedded PCs.

- Switch off the power supply for the Embedded PC during disassembly.

Cabling

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

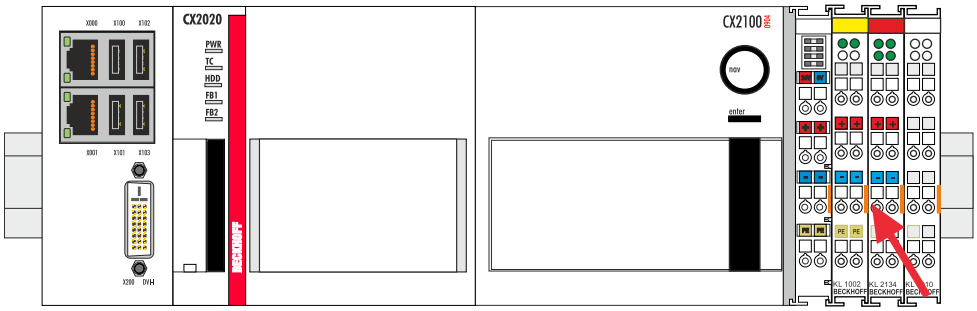
Before dismantling the embedded PC, shut down the embedded PC and switch off the power supply. Only then can you remove all the cables. Also remove all cables from the first terminal after the power supply terminal.

Requirements:

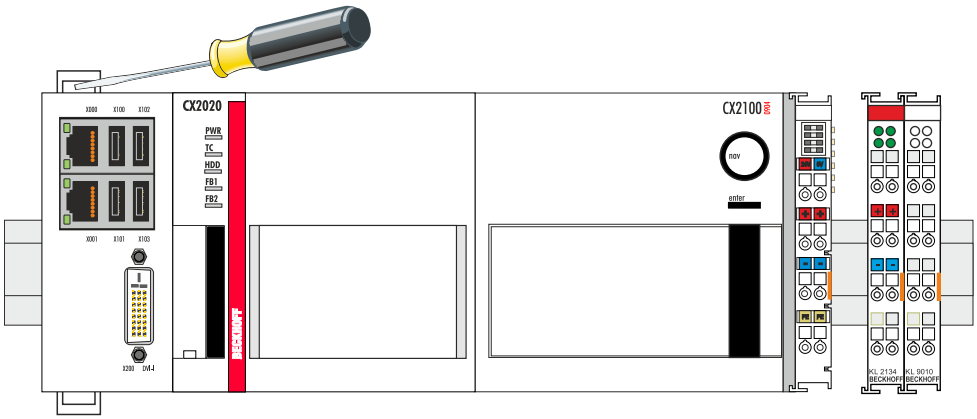
- Exit the software and shut down the embedded PC.
- Switch off the power supply.

Remove the cables as follows:

1. Remove the wiring from the basic CPU module, any system interfaces that may be connected and the extension modules.
2. Remove the wiring from the first terminal next to the power supply terminal.
3. Pull the orange strap to remove the first terminal after the power supply terminal by pulling it forward.



⇨ In the next step the embedded PC can be removed from the DIN rail and dismantled.



8.2 Disassembling the power supply unit

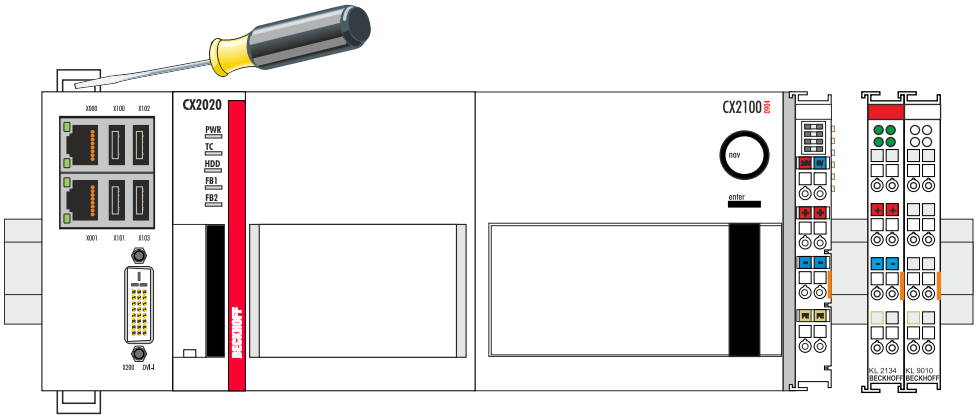
The CX2000 Embedded PC series is a modular system and enables individual modules to be replaced or removed quite easily. This section describes how to remove devices from the CX2000 Embedded PC series.

Requirements:

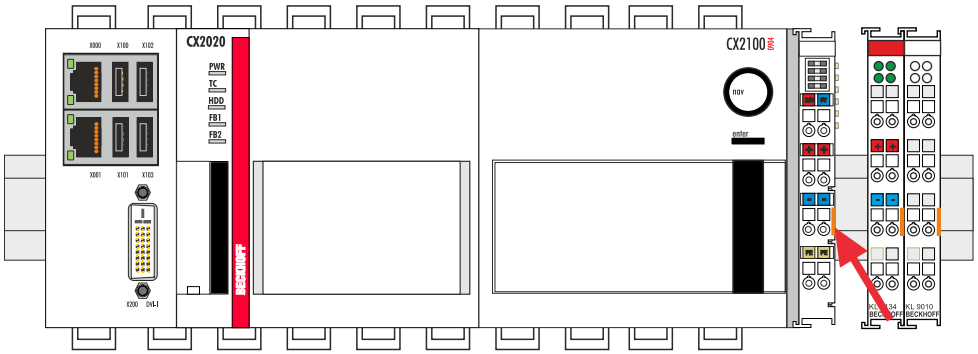
- All cables were removed from the embedded PC.

Dismantle the embedded PC as follows:

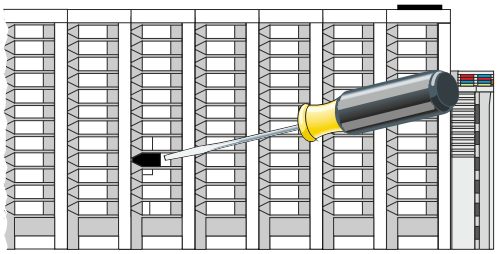
1. Release the DIN rail mounting by pushing the latches outwards with a screwdriver.

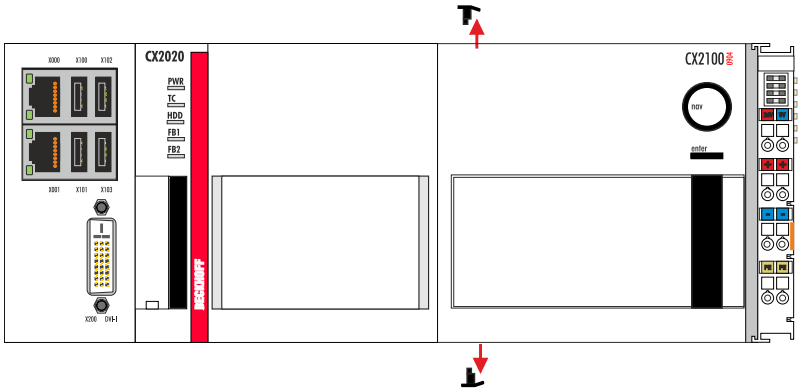


2. Pull the orange strap on the power supply unit and gently remove the device from the DIN rail.



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.

9 Technical data

Table 13: Technical data, dimensions and weights.

Technical data	CX2100-0904
Dimensions (W x H x D)	118 mm x 100 mm x 91 mm
Weight	1025 g

Table 14: Technical data, general data.

Technical data	CX2100-0904
Power supply	24 V DC (-15 %/+20 %)
Dielectric strength	500 V (supply / internal electronics)
Connection type	spring-loaded system
Max. output	45 W
Max. power loss	3.5 W
Max. power consumption E-bus/K-bus	10 W (5 V/max. 2 A)
UPS	capacitive integrated
Capacity	75 As
Display	FSTN display 2 lines x 16 characters of text, illuminated
Diagnostic LED	1 x PWR, 1 x I/O Run, 1 x I/O Err
Approvals	CE, UL

Table 15: Technical data, I/O terminals.

Technical data	CX2100-0904
I/O connection	K-bus or E-bus, automatic recognition
Power supply for I/O terminals	max. 2 A
Power contacts current loading	max. 10 A
Process data on the K-bus	max. 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 16: Technical data, environmental conditions.

Technical data	CX2100-0904
Ambient temperature during operation	-25 °C ... +50 °C
Ambient temperature during storage	-25 °C ... +60 °C
Relative humidity	95% no condensation
Shock resistance	conforms to EN 60068-2-27
Vibration resistance	conforms to EN 60068-2-6
EMC immunity	conforms to EN 61000-6-2
EMC emission	conforms to EN 61000-6-4
Protection rating	IP20

10 Appendix

10.1 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.

10.2 Support and Service

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

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More Information:
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