Hardware Documentation

CX1100-00xx

Embedded-PC

Version: 2.1
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BECKHOFF

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1 Foreword

1.1 Notes on the documentation

This description is only intended for the use of trained specialists in control and automation engineering who are familiar with the applicable national standards.
It is essential that the following notes and explanations are followed when installing and commissioning these components.

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

Disclaimer

The documentation has been prepared with care. The products described are, however, constantly under development.
For that reason the documentation is not in every case checked for consistency with performance data, standards or other characteristics.
In the event that it contains technical or editorial errors, we retain the right to make alterations at any time and without warning.
No claims for the modification of products that have already been supplied may be made on the basis of the data, diagrams and descriptions in this documentation.

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1.2 Safety instructions

Safety regulations

Please note the following safety instructions and explanations!
Product-specific safety instructions can be found on following pages or in the areas mounting, wiring, commissioning etc.

Exclusion of liability

All the components are supplied in particular hardware and software configurations appropriate for the application. Modifications to hardware or software configurations other than those described in the documentation are not permitted, and nullify the liability of Beckhoff Automation GmbH & Co. KG.

Personnel qualification

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

Description of symbols

In this documentation the following symbols are used with an accompanying safety instruction or note. The safety instructions must be read carefully and followed without fail!

 **DANGER**	**Serious risk of injury!** Failure to follow the safety instructions associated with this symbol directly endangers the life and health of persons.
 **WARNING**	**Risk of injury!** Failure to follow the safety instructions associated with this symbol endangers the life and health of persons.
 **CAUTION**	**Personal injuries!** Failure to follow the safety instructions associated with this symbol can lead to injuries to persons.
 **Attention**	**Damage to the environment or devices** Failure to follow the instructions associated with this symbol can lead to damage to the environment or equipment.
 **Note**	**Tip or pointer** This symbol indicates information that contributes to better understanding.

1.3 Documentation Issue Status

Version	Changes
0.1	preliminarily version

Version	Changes
0.2	revised version description of four power supplies CX10xx architecture description
1.0	memory mapping / fieldbus connections
1.1	library for 4 + 1 navigation switch added
1.2	Blink codes for CX1100-0004 (EtherCAT) extended
1.3	Changes in GCB - Watchdog Error Counter
1.4	Display access via ADS added
1.5	Blink codes for IP-Link errors added
1.6	Notes on hardware revision added
1.7	Terminal bus diagnosis in PLC program added
1.8	Notes on terminal bus diagnosis with firmware > B7 added
1.9	Notes on wire installation added
2.0	Notes on new power supplies for CX1030 added
2.1	Revised version

2 Product overview

2.1 Appropriate Use

The CX1020 device series is a modular control system designed for top-hat rail installation. The system is scalable, so that the required modules can be assembled and installed in the control cabinet or terminal box as required.

2.2 System Overview

CX1100-00xx power supply units and I/O interfaces

One of four power supply modules can be selected for a CX10x0 system. The power supply of all other system components is ensured via the internal PC104 bus; no separate supply lines are required. However, the CX1100 components offer further important characteristics that go beyond a pure power supply: an integrated NOVRAM enables the fail-safe storage of process data, an LCD display with two lines of 16 characters each is used for displaying system and user messages.

Local I/O signals are connected via the CX1100-0002 power supply variant, to which all Beckhoff Bus Terminals can be connected, or via CX1100-0003, which in addition to the Bus Terminals enables the connection of Extension Box IExxxx type Beckhoff Fieldbus Box modules. The option to connect Bus Terminals or Fieldbus Box modules creates a control system with a very variable, expandable I/O level with large signal variety. The I/O data are stored in a DPRAM, which is accessible by the CPU via the system bus. The power supplies of the CX system can be changed in the field: If, for example, local I/O via Bus Terminals is required, CX1100-0001 can be replaced with CX1100-0002 in the field. Local I/O signals are connected via the CX1020 and the CX1100-0002 power supply variants (Bus Terminals), CX1100-0003 (Bus Terminals
and Fieldbus Box modules via IP-Link) or CX1100-0004 for EtherCAT Terminals. With CX1100-0004 the I/O

data are stored directly in the main memory of the CPU; a DPRAM is no longer required. The CX1100-0004 power supply unit for EtherCAT Terminals can only be connected in conjunction with the basic CX1020/ CX1000/CX1010 CPU module.

For the *CPU CX1030* a modified power supply unit is necessary. For this use the modules *CX1100-001x* . The functions are similar to the modules CX1100-000x.

The technical data are as follows:

- CX1100-0001
- CX1100-0002 / CX1100-0012
- CX1100-0003 / CX1100-0013
- CX1100-0004 / CX1100-0014

An overview about architecture with the common system components GCB, ACB, NOVRAM, display and switch are described together in one chapter. Special interfaces are described in the power supply units containing the interfaces.

Also see about this

- Architecture of the power supply units [▶ 10]
- Display setup [▶ 18]
- Operating principle of the switch [▶ 24]

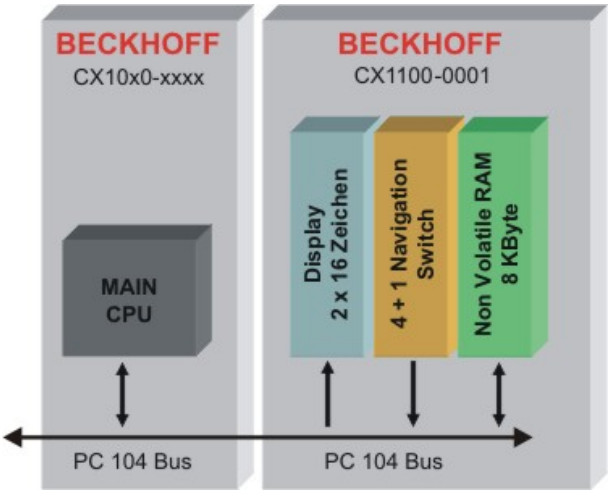
2.3 Architecture of the power supply units

The four power supply units for the CX10x0-System accomplish more task than supporting the system with power. Each module has three basic functions. Additional each model supports different connection to communication busses. Caused by these different connections the internal architecture differ. At first the common functions are described.

All power supply feature, except for power supply, the following functions:

1. Display 2 x 16 characters
2. 4+1 navigation switch
3. Non Volatile RAM

These functions are managed by the control program via the PC104 bus. The structure of the CX1100-0001 is shown in the following figure:



"General Control Block" (GCB)

The top 16 byte of the system control area (starting at the physical hex address D0000 + Offset FF0) form the general control block GCB, which holds the control byte required to start the I/O processing of the K-Bus and IP-Link.

The CPU of the main module controls the whole architecture. With memory mapped I/O regions data can be exchanged. The data needed to run the system is combined in the "General Control Block" (GCB). Its base address is "0xD1000". The figure shows the Data and the offset. Some registers are not needed in all units. So only the requested registers are mapped other addresses are masked out.

General Control Block (GCB)

0xFF0	Firmware Version
0xFF1	Firmware Revision
0xFF2	Service Request Bitfield
0xFF3	Service Response Bitfield
0xFF4 0xFF5	Watchdog Time [ms]
0xFF6 0xFF7	Cycle Time [ms]
0xFF8	Watchdog Error Counter
0xFF9	Processdata Error
0xFFA	Processdata Cycle Overrun
0xFFB	not used
0xFFC	not used
0xFFD	Processdata Ready
0XFFE	Processdata Request
0XFFF	not used

Firmware Version:

These two bytes contain the hex decimally coded version number of the CX1100 firmware. E.g. the first byte could show B3(hex): this results in firmware version B3.

Firmware Revision:

These two bytes contain the hex decimally coded revision number of the CX1100 firmware. E.g. the byte could show 00: this results in revision 00.

Service Request / Response Bitfield: (only for CX1100-0002 / -0003)

These two bytes contain a sequence of bits, by which certain service functions may be executed. The service function is invoked by setting the appropriate request bit, the controller executes and sets the response bit. Before the same function can be invoked again, the request bit must be set to zero and wait until the response bit is also set to zero. An execution error is signaled by raising response bit 7.

Bitfeld	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Request	-	-	-	-	-	Link Images	Remap	Reset Node
Response	Error	-	-	-	-	Images Linked	Remapped	Reset Done

Reset Node:

with this bit, a software reset of the 80C165 microcontroller can be performed. This is different from the hardware reset which may be performed in the Auxiliary Control Block (ACB).

Remap:

with this bit, the two-byte PLC interfaces normally residing in the input/output process areas can be remapped into the general control block for K-Bus and IP-Link. Thus the input/output process image areas can be kept clean and for the sole purpose of storing I/O-data.

Link Images:

if set, this bit links the K-Bus logically to the IP-Link in the case of error occurrence - meaning that if one of them stops operating, the other one is stopped as well. By default, this bit is set so stopping both I/O systems in case of error is the standard behavior.

Watchdog Time:

With the request of an I/O cycle through "PD cycle request", a watchdog timer with this specified millisecond time is started. If the cycle is not being restarted by a next "PD cycle request", the watchdog elapses and as a consequence the output process image is zeroed. This resets all outputs to a safe state (OFF). It also increments the value in "Watchdog Error Counter" by one. If another value than the default 100ms is written to this cell, a "Reset node" is needed to activate the change.

Cycle Time:

This is the time elapsed between the initiation and termination of an I/O process image update (K-Bus + IP-Link). The time is recorded in units of microseconds and starts with writing a new cycle request to the field "PD cycle request" and it stops with the termination response in the field "PD cycle ready". For CX1100-0002 this time reflects the K-Bus update time, for CX1100-0003 it is the sum of K-Bus update time and IP-Link update time.

Watchdog Error Counter:

If the Watchdog Time exceeds the value in this register is increased by one. In this way the user can get the numbers of watchdog-time errors. (available since firmware revision B6)

Processdata Error:

This byte contains the information on the error status of the I/O blocks. The possible bit codes are:

Bitfeld	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Processdata Error	-	-	-	-	-	-	IP-Link Error	K-Bus Error

The bit is set to "TRUE", if an error occurred. If both bits are zero, there is no error on either bus system. Error recovery may be attempted by invoking the "Reset bus" service in the corresponding CB of either K-Bus or IP-Link.

Processdata Cycle Overrun:

This byte contains a counter, which is incremented each time a new process data cycle is requested although the previous cycle has not yet completed. This can happen only due to a handshake programming error or if the user task cycle time is shorter than the time for I/O update.

PD Cycle Ready / PD Cycle Request:

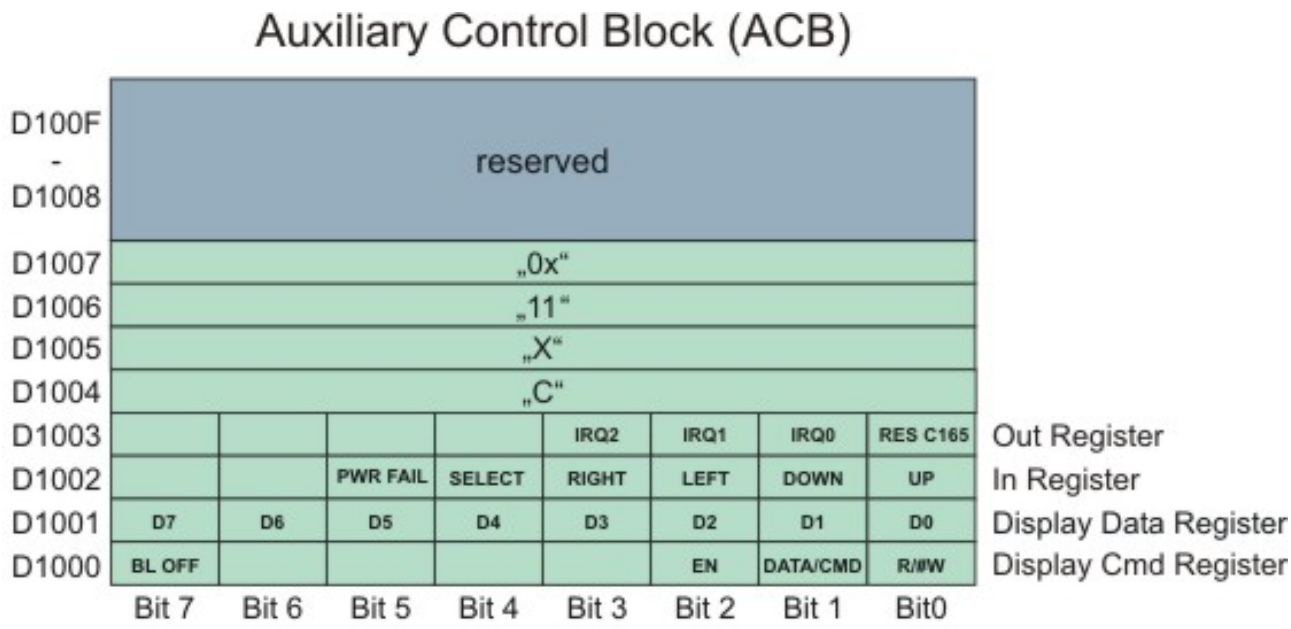
These two bytes contain the request value and the ready value for operating a process data (PD) I/O cycle. The user program is supposed to write a pattern (e.g. an up-counter value) to the request byte, thus triggering the I/O cycle. Once the I/O cycle is finished, the microcontroller will set the ready byte to match the request byte. A new request can then be written to the request byte.

"Auxiliary Control Block" (ACB)

The Auxiliary Control Block of CX1100 is a block of 16 bytes and starts at address D1000 (hex). It is a miscellaneous control block for controlling:

- the 2x16char FSTN LCD Display
- the navigation switch
- the hardware reset of the 80C165 microcontroller

The following schematic shows the layout of the ACB and is followed by a description of the single bits contained in it.



Display Cmd Register:

R/#W: This bit control the Read or Write operation for programming the display2x16 char LCD display.

DATA/#CMD: This bit controls whether the byte "Display Data Reg" holds a command or display data.

EN: This is the enable bit for executing the operation with the display controller.

BL OFF: If set, this bit turns of the backlight of the LCD Display. This feature may be used for blinking with the backlight, thus attracting the users attention to an important message on the display. It may also be used to save power in the case of power loss and UPS operation.

Display Data Register:

These are the data bits for issuing commands or reading/writing data to the display controller. These bits are operated in conjunction with bits 0,1,2 of the Display Cmd Reg. For more detailed information please refer to the display controller documentation.

In Register:

These bits reflect the contact status of the 4+1 direction navigation switch on the front side of the CX1100 unit. These events may be used by a software for implementing a menu driven data input/output together with the LCD display.

Bit 0 UP
Bit 1 DOWN
Bit 2 LEFT
Bit 3 RIGHT
Bit 4 SELECT
Bit 5 PWR-FAIL (reserved for future use - do not use)

An example for access the switch is given in the detailed description of the switch.

Out Register:

Bit 0 RES C165
This bit resets the microcontroller 80C165 and restarts the initialization of the K-Bus and IP-Link circuit. For doing the reset, this bit must be set high and then set back to low. There is no need for an explicit hold time. This bit may be used to recover from K-Bus faults such as removing a terminal during operation. It needs to be set at least once at startup or initialization of the user software before operating the k-Bus.

Bit 1 IRQ0 (reserved for future use - do not enable)
Bit 2 IRQ1 (reserved for future use - do not enable)
Bit 3 IRQ2 (reserved for future use - do not enable)

Memory region 0xD1004 to 0xD1008:

In this region the type of the power supply module is encoded. By adding the four registers the type description is given:

CX1101 CX1100-0001 power supply unit with display, 4 + 1 navigation switch and NOVRam

CX1102 CX1100-0002 power supply unit with display, 4 + 1 navigation switch, NOVRam and K-bus connection

CX1103 CX1100-0003 power supply unit with display, 4 + 1 navigation switch, NOVRam, K-bus-connection and IP-Link-connection

CX1104 CX1100-0004 power supply unit with display, 4 + 1 navigation switch, NOVRam and E-bus connection.

The Non Volatile RAM

The NOVRAM is one of the most important functions of the power supply unit. The access is realized via the PC104 bus. The mapping to PLC is realized by TwinCAT System Manager. Here needed variables can be defined and mapped to memory. Further details are given in the TwinCAT documentation.

K-BUS and IP-LINK Operation

This section describes how to trigger the K-Bus (and in the case of CX1100-0003 also the I/O-boxes connected to IP-Link) in order to read input values and write output values. The procedure is the same for IP-Link, the description limits itself to K-Bus for textual simplicity.

The I/O operation is done through the bytes named "PD cycle ready" and "PD cycle request" in the GCB. The K-Bus cycle is triggered by a write operation to the byte "PD cycle request". Although the value being written to this byte does not matter (it is only the write operation which is important), it is recommendable write a counter-up value to this byte. The microcontroller for the K-Bus will react to the write operation by performing a K-Bus cycle and gathering the I/O data. Once the cycle is completed and the electrical signal input data are written to the DP-RAM, the microcontroller will set the content of byte "PD cycle ready" equal to the content of "PD cycle request", thus signaling the completion of the I/O cycle. The time required to run a K-Bus cycle depends on the number of terminals attached to CX1100: it is minimum 700 microseconds and typically well below 5 milliseconds. The K-Bus cycle time can be viewed by using the TwinCAT System Manager tool, by entering the exact terminal configuration.

At startup of the user program, before going into cyclic operation, it is mandatory to reset the K-Bus controller by triggering the "RES C165" bit in the Auxiliary Control Block section of CX1100. Please refer to the description of the ACB for how to do this.

The sequence of operating the K-Bus can be explained by assuming a cyclic automation task executed each 10 ms on the main CX1000 CPU:

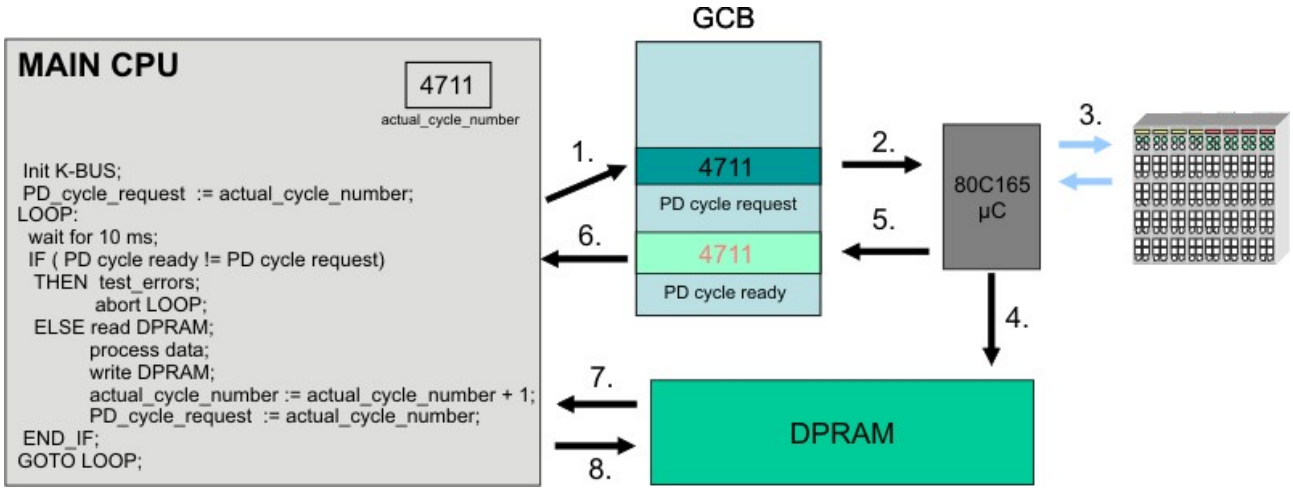
Task cycle "n":

- check if K-Bus operation of previous cycle has finished: is "PD cycle ready" = "PD cycle request" ? Proceed if yes, issue error message and abort cyclic task operation if not, because a K-Bus cycle does not need 10 milliseconds to finish !

- read the input data from the DP-RAM (these are the input data gathered by the previous cycle "n-1")
- write the output data to the DP-RAM (these are the outputs calculated by the previous cycle "n-1").
- increment and write the new value to "PD cycle request"
- perform task user code

Task cycle "n+1":

- check if K-Bus operation of previous cycle has finished: is "PD cycle ready" = "PD cycle request" ? Proceed if yes, issue error message and abort cyclic task operation if not, because a K-Bus cycle does not need 10 milliseconds to finish !
- read the input data from the DP-RAM (these are the input data gathered by the previous cycle "n")
- write the output data to the DP-RAM (these are the outputs calculated by the previous cycle "n").
- increment and write the new value to "PD cycle request"
- perform task user code



Of course only the I/O bytes needed should be copied to or from the DP-RAM, since each read or write operation over PC104 is time consuming. Please note that the terminal outputs need a K-Bus refresh no later than 100 milliseconds, otherwise the watchdog in each terminal will shut off the outputs. This means that the task cycle time should be below 100 milliseconds. Also, if more than one cyclic automation task needs access to K-Bus I/O, it is important that only one task operates the K-Bus and the other tasks implement an I/O buffering in order to have a consistent I/O image. In this scenario, the task with the highest priority has the shortest cycle time and will trigger the K-Bus.

Please note also that it is assumed that in each cycle the integrity of the K-Bus is being checked by examining the "Processdata error" field in the GCB. Cyclic operation should be aborted in the case of an I/O error and user should be prompted for corrective actions. Cyclic operation can be resumed after resetting the faulty bus over the service request fields of the control block.

2.4 Adapter RAM Hardware address overview

available memory addresses CX1020: D0000-DFFFF (hex)

Base Address (hex)	End Address (hex)	Size(Bytes)(hex)	Access Type	Description
D0000	D0FFF	1000	R/W	CX1100-0002/3 Dual Ported RAM
D1000	D100F	10	R/W	CX1100 Auxiliary Control Block(LCD Display, misc. registers)

Base Address (hex)	End Address (hex)	Size(Bytes)(hex)	Access Type	Description
D1010	D101F	10	R/W	CX1100-0900 UPS Control Block
D2000	D3FFF	2000	R/W	CX1100 Non Volatile RAM
D4000	D5FFF	2000	R/W	CX1500-M310 Profibus Master DPRAM
D6000	D7FFF	2000	R/W	CX1500-M510 CANopen Master DPRAM
D8000	D9FFF	2000	R/W	CX1500-M520 DeviceNet Master DPRAM
DA000	DBFFF	2000	R/W	CX1500-M200 Lightbus Master DPRAM
DC000	DDFFF	2000	R/W	CX1500-M750 Sercos Master DPRAM

For some fieldbus connections (all Slave modules) the base addresses are mapped in the memory region upper DFFFF(hex). So this modules must be ordered with other base addresses. The same situation takes place if more than two or more master modules of same type are used (for more see note below). The order numbers for the modules are:

order number	alternative ISA address
Master connection	
CX1500-Mxxx-0001	D4000
CX1500-Mxxx-0002	D6000
CX1500-Mxxx-0003	D8000
CX1500-Mxxx-0004	DA000
CX1500-Mxxx-0005	DC000
Slave connection	
CX1500-Bxxx-0001	D4000
CX1500-Bxxx-0002	D6000
CX1500-Bxxx-0003	D8000
CX1500-Bxxx-0004	DA000
CX1500-Bxxx-0005	DC000

Replace xxx with the following number for the requested fieldbus system:

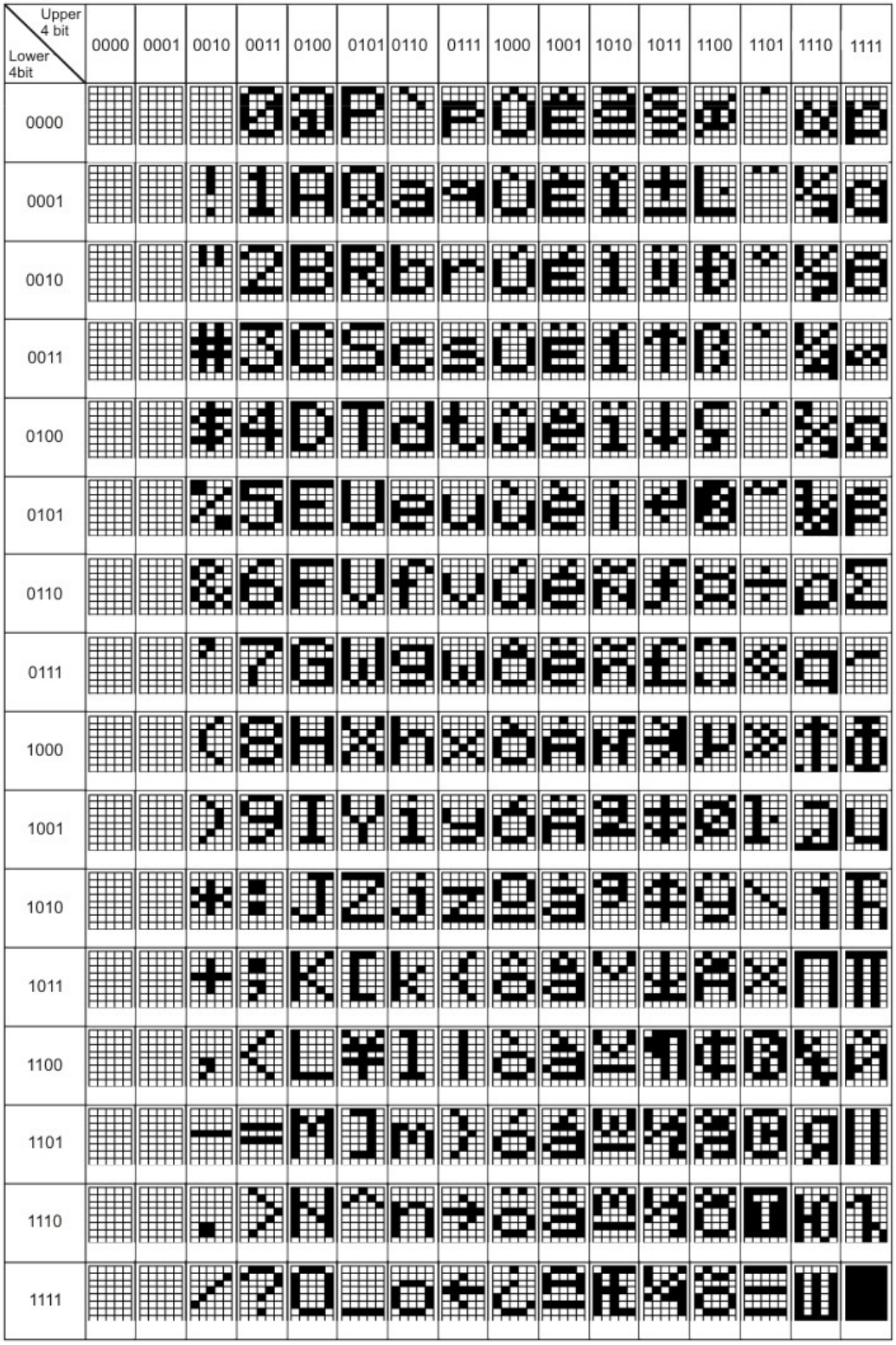
- 200 for Lightbus
- 310 for Profibus
- 510 for CAN-open
- 520 for DeviceNet
- 750 for Sercos (only Master connection available)

Note	Two connection modules (master or slave) can be used simultaneously. If more than two connections are needed call Beckhoff Automation GmbH for further information.

2.5 Display

2.5.1 Display setup

The display built-in the CX1100-000x units, is a LCD display. It features 2 lines with 16 characters. Each character has a resolution of 5 x 8 pixel. The font is named SPLC780C-11 and is fixed. The following figure shows the the font with all available characters.



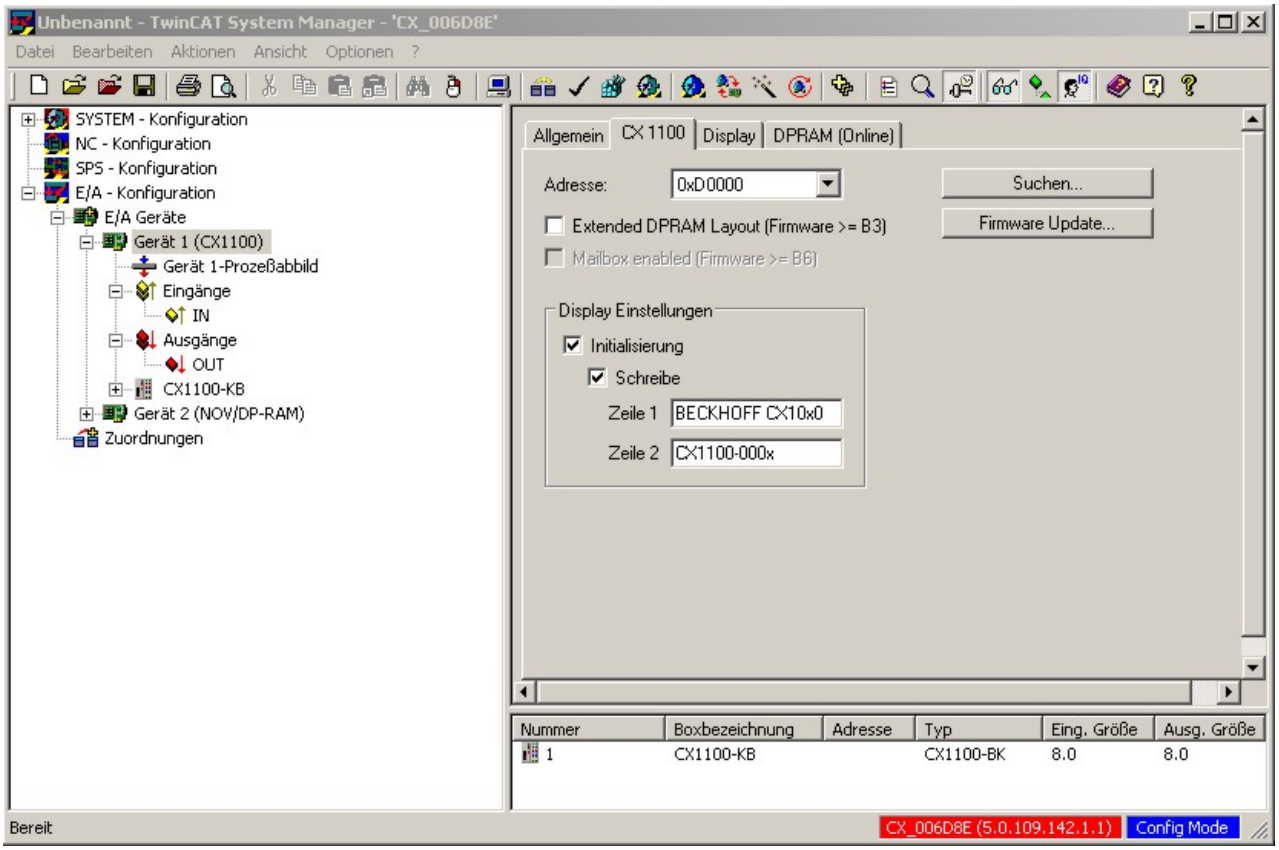
For easy reading a background illumination is integrated to the display. The illumination can be switch on and off. This blinking can be used to attract the user in certain situations. The state can be set via the controller. The controller reads the registers in "Auxiliary Control Block" and addresses the display in the desired manner.

2.5.2 Representing text on the display

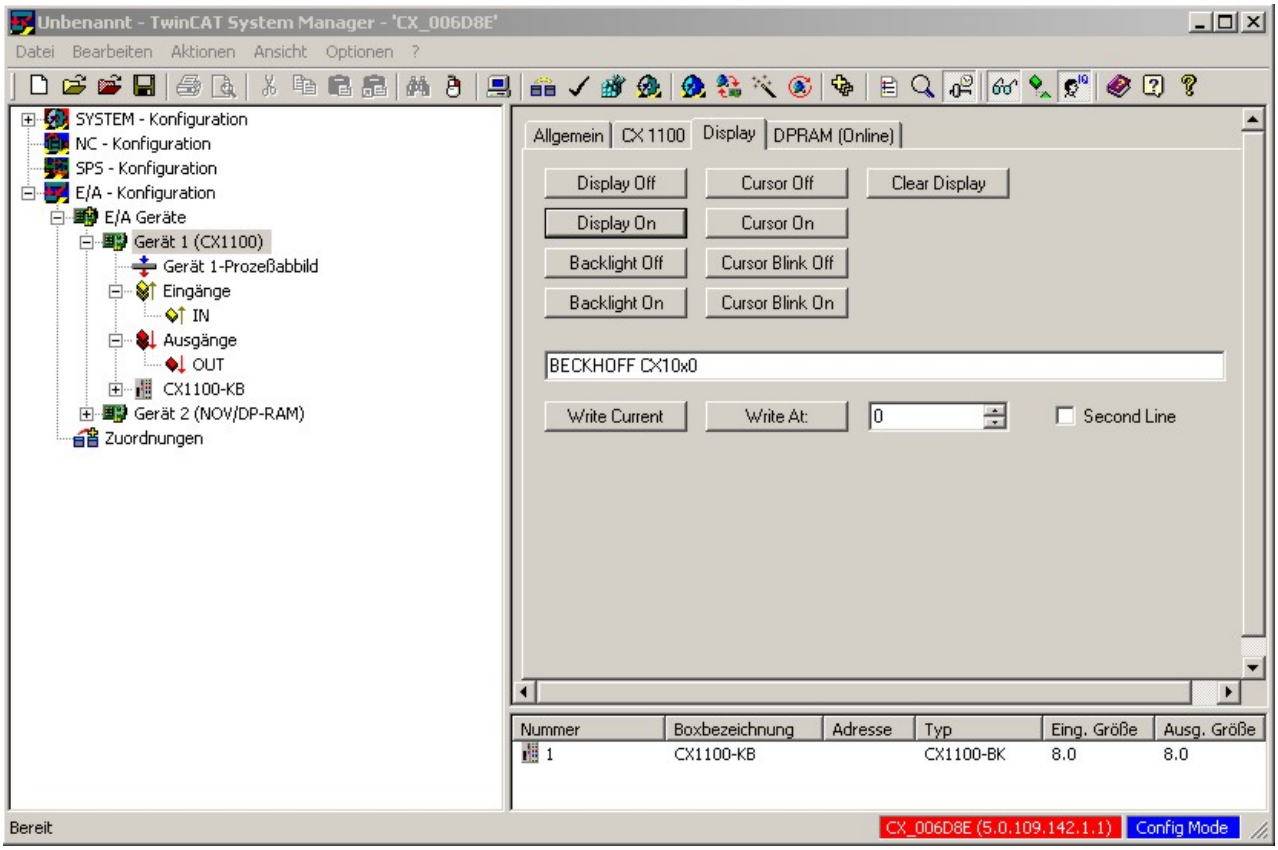
The display can be controlled in two ways with the aid of TwinCAT. One version is programming through the System Manager. A second possibility is for the display to be written by a function block directly from the PLC program.

Settings in the System Manager

When the TwinCAT system starts, the text specified in the configuration can be written to the display. This text is set in the System Manager.



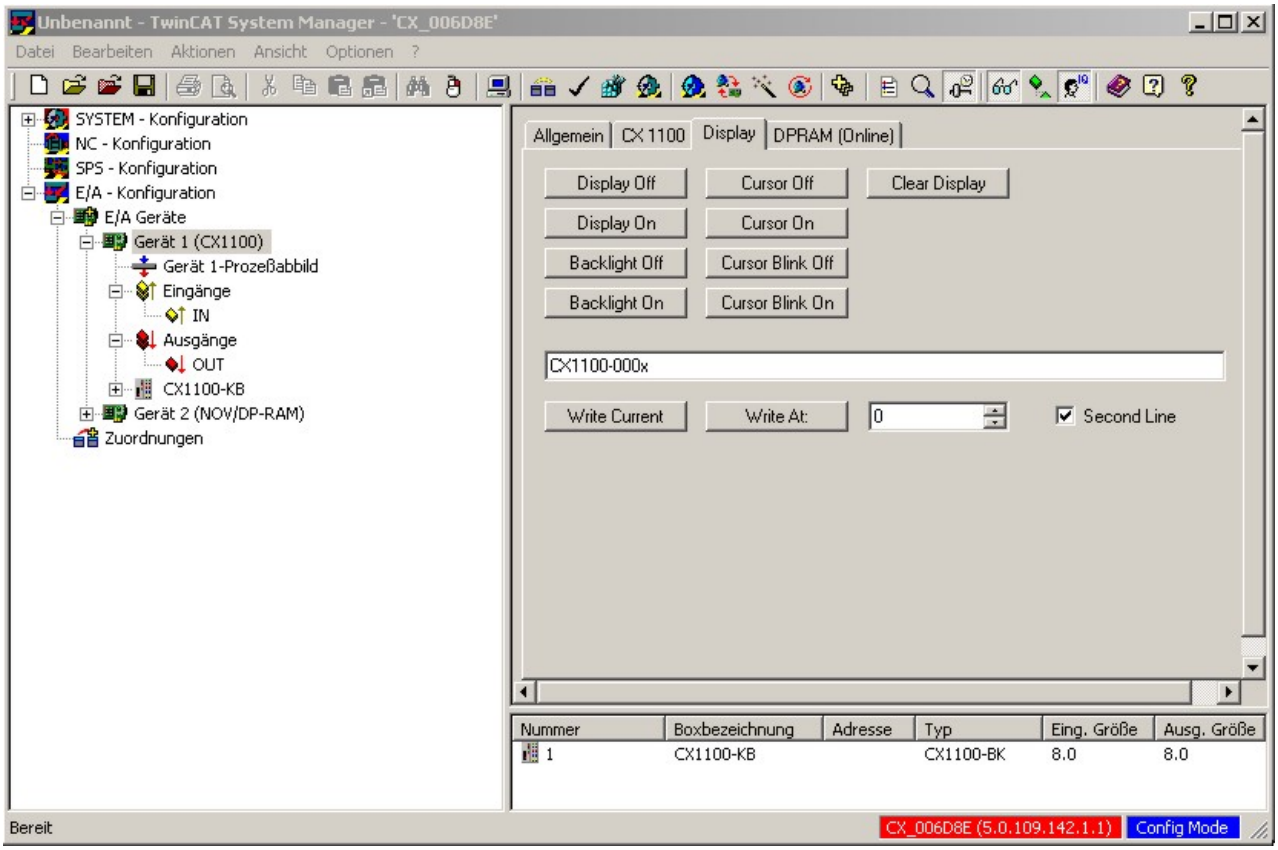
This is done by selecting the CX10x0 device in the hierarchy browser. Under the CX1100 tab it is possible to write both lines of the display in the "Display settings" area. This requires the fields at the location for initialisation and writing to be selected. The changes only take effect after the configuration has been written. When TwinCAT restarts, the set text is then displayed.



The display can be controlled directly through the Display tab. The corresponding functions are carried out immediately through the switches. It is possible to execute the following functions:

- Switch the display on/off (text is displayed/hidden)
- Background illumination on/off
- Clear the display (text is cleared, and must be re-entered)
- Cursor on/off (the cursor is displayed)
- Cursor flash on/off (the cursor flashes)

The desired text is entered into the text input field. The "Write current" switch inserts the text at the current position of the cursor.



Using the "Write At" switch, the numerical input box and the "Second Line" check box, it is possible to write to a specified position on the display. The useful range of values for the position extends from 0 to 15. The user should also, however, consider the length of the text. (Each line has 16 characters!) In the example illustrated below, the text "CX1100-000x" is written to Position 0 (the start of the line) on Line 2.

Settings in the PLC program

The function block FB_CX1000SetTextDisplay is provided in the library for the CX family (TcCX1000System.lib) in order to operate the display from a PLC program. All the functions of the display can be manipulated from this function block. The library must, however, be integrated through the library administrator. If this has been done, the block is available as a function block. It is instanced as such in the declarations part of the program.

```
PROGRAM MAIN
VAR
    Display_0 :  FB_CX1000SetTextDisplay;
END_VAR
```

It is then called from the program with its parameters. There are five parameters for this function block:

- bExecute : BOOL
- nDevID : UDINT
- nMode : E_CX1000_DisplayModes
- stLine : STRING(20)
- nCursorPos : DWORD

The command is executed in response to a rising edge at "bExecute". "nDevID" provides the Device ID of the CX1100 that is to be written to. The ID is displayed in the System Manager. (The General tab for the CX1100, top right). The parameter "stLine" is used to pass a text of at most 20 characters. Only the first 16 of these characters, however, will be displayed. The writing position of the text uses quoted through "nCursorPos". 0 to 15 is a useful range for this value. "nMode" selects the operating mode of the function block. The modes are:

- **e_CX1000_DisplayNoAction** : No action.
- **e_CX1000_DisplayOn** : Switch on the display.
- **e_CX1000_DisplayOff** : Switch off the display.
- **e_CX1000_CursorOn** : Switch on the cursor.
- **e_CX1000_CursorOff** : Switch off the cursor.
- **e_CX1000_CursorBlinkOn** : Switch on the cursor flashing.
- **e_CX1000_CursorBlinkOff** : Switch off the cursor flashing.
- **e_CX1000_BackLightOn** : Switch on the background illumination.
- **e_CX1000_BackLightOff** : Switch off the background illumination.
- **e_CX1000_ClearDisplay** : Clear the content of the screen.
- **e_CX1000_WriteLine1** : Write to the first line.
- **e_CX1000_WriteLine1** : Write to the second line.

The call then looks like this:

```
Display_0(
    bExecute := write_now,      (* write_now is a boolean value, and functions as switch)
    nDevID  := 1,           (* DeviceID of the CX1100 *)
    nMode   := e_CX1000_WRITELine1, (* Write to the first line of the display *)
    stLine  := 'Beckhoff CX1100',   (* Fixed text, although variable can also be put here *)
    nCursorPos := 0         (* Writing position is 0, i.e. the start of the line *)
);
```

The block supplies a few status signals for evaluating the program environment. These can be used to provide feedback to the PLC program. There are three response signals from the function:

- bBusy : BOOL
- bErr : BOOL
- nErrorID : UDINT

"bBusy" indicates that the command is at present being transferred by ADS. No new command will be accepted as long as "bBusy" remains TRUE. "bErr" reports an error in a call to a function block. (The signal becomes TRUE). "nErrorID" permits the error that has occurred to be analysed by means of an error number. The error number [▶ 75] refers to an error in the ADS protocol.

2.5.3 LC Display

The LC Display of the power supply units has two rows of 16 characters each and is used for displaying system and user messages.

"Index-Group/Offset" Specification for the LC Display

ADS Port 300

Index Group	Index Offset	Access	Data type	Phys. Unit	Def. Range	Description	Remarks
0x00005000 + DeviceID	0xFFFF90FF	R&W				Cursor OFF	
0x00005000 + DeviceID	0xFFFF91FF	R&W				Cursor ON	
0x00005000 + DeviceID	0xFFFF92FF	R&W				Cursor blink OFF	
0x00005000 + DeviceID	0xFFFF93FF	R&W				Cursor blink ON	
0x00005000 + DeviceID	0xFFFF94FF	R&W				Display OFF	
0x00005000 + DeviceID	0xFFFF95FF	R&W				Display ON	
0x00005000 + DeviceID	0xFFFF96FF	R&W				Backlight OFF	
0x00005000 + DeviceID	0xFFFF97FF	R&W				Backlight ON	
0x00005000 + DeviceID	0xFFFFA0FF	R&W				Write Text line 1	
0x00005000 + DeviceID	0xFFFF00FF	R&W				Write Text line 2	

2.6 4 + 1 navigation switch

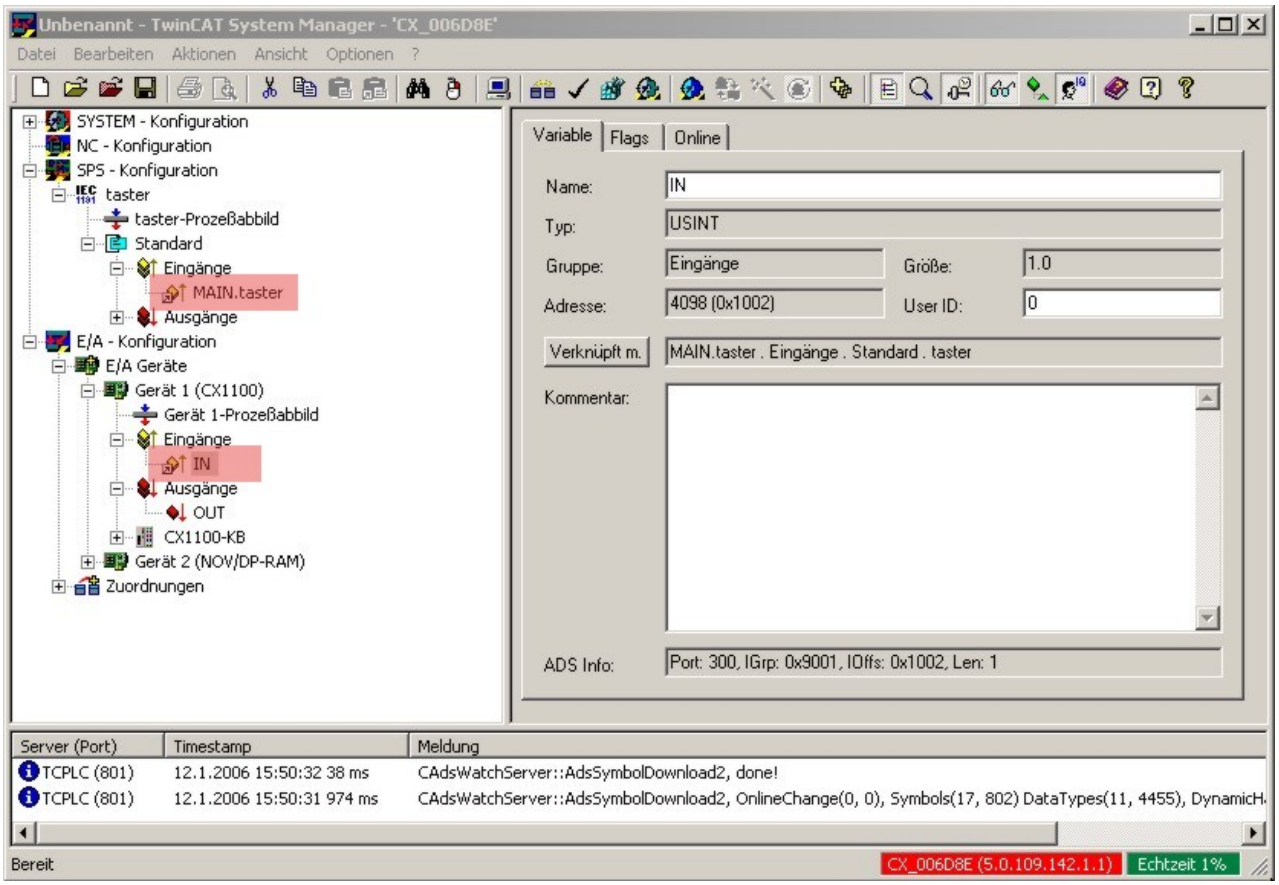
2.6.1 Operating principle of the switch

The CX1100-000x power supply units all have 4 + 1 navigation switches. The switches can therefore be used to input five basic states:

1. UP
2. DOWN
3. LEFT
4. RIGHT
5. SELECT

Combined inputs, such as UP + RIGHT or UP + RIGHT + SELECT can also be entered. The values of the switches are stored in a register of the "Auxiliary Control Block", ACB. Details may be referred to in the architectural description.

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 linked in the TwinCAT System Manager to the IN-register of the CX1100.



The figure shows the linked signals (with a bright red background). The switch can be accessed from the PLC program through the Switch variable. The PLC program takes the form described below. To begin an external variable is declared as an input. (In this example it is at address 0)

```
PROGRAM MAIN
VAR
    Taster AT %IB0 : USINT;
END_VAR
```

A simple CASE statement can then be used to evaluate the switch, and the desired function can be initiated, e.g.:

```
CASE Taster OF
0:      ACTION := NONE;
1:      ACTION := UP;
2:      ACTION := DOWN;
4:      ACTION := LEFT;
8:      ACTION := RIGHT;
16:     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 (1) and RIGHT (8) would be 8 + 1 = 9. In this way, only sensible combinations are possible. In other words, switch positions that are opposite to one another cannot be selected without damaging the switch.

If the programmer does not want to carry out the evaluation, the TwinCAT System provides a library function that implements conversion of the switch input into an ENUM type. For this purpose, the library for the CX Systems, TcSystemCX.lib, must be integrated into the library manager. The function is called "F_CXNaviSwitch(iCX1100_IN : USINT)", and returns an ENUM type. This encodes the direction of the switch that has been pressed as names, for example e_CX1100_NaviSwitch_MIDDLE for <Middle>. The full list of valid possibilities is:

- e_CX1100_NaviSwitch_IDLE
- e_CX1100_NaviSwitch_MIDDLE
- e_CX1100_NaviSwitch_TOP
- e_CX1100_NaviSwitch_TOPRIGHT
- e_CX1100_NaviSwitch_RIGHT
- e_CX1100_NaviSwitch_BOTTOMRIGHT
- e_CX1100_NaviSwitch_BOTTOM
- e_CX1100_NaviSwitch_BOTTOMLEFT
- e_CX1100_NaviSwitch_LEFT
- e_CX1100_NaviSwitch_TOPLEFT
- e_CX1100_NaviSwitch_MIDDLE_TOP
- e_CX1100_NaviSwitch_MIDDLE_TOPRIGHT
- e_CX1100_NaviSwitch_MIDDLE_RIGHT
- e_CX1100_NaviSwitch_MIDDLE_BOTTOMRIGHT
- e_CX1100_NaviSwitch_MIDDLE_BOTTOM
- e_CX1100_NaviSwitch_MIDDLE_BOTTOMLEFT
- e_CX1100_NaviSwitch_MIDDLE_LEFT
- e_CX1100_NaviSwitch_MIDDLE_TOPLEFT

Further details on the function can be read in the TwinCAT documentation. The function can be used in a program as follows: (The declaration and linking are as given in the example above)

```
CASE F_CXNaviSwitch(Taster) OF
e_CX1100_NaviSwitch_IDLE            :;          (* do nothing *)
e_CX1100_NaviSwitch_MIDDLE              :call_select;   (* select item *)
e_CX1100_NaviSwitch_TOP             :call_prev_item;(* previous menue item *)
e_CX1100_NaviSwitch_RIGHT               :call_inc_value;(* increase value *)
e_CX1100_NaviSwitch_BOTTOM              :call_next_item;(* next menue item *)
e_CX1100_NaviSwitch_LEFT            :call_dec_value;(* decrease value *)
END_CASE;
```

Further evaluation of the switch inputs is then done later in the program.

2.7 CX1100-0001

2.7.1 CX1100-0001 connections

This power supply unit does not have an I/O interface. The power supply is therefore connected through the 5-pin open pluggable connector. The power supply unit supplies all further system components with a voltage of 24 V DC (-15 %/+20%) via the PC104 bus. The dielectric strength of the power supply unit is 500 V_{rms}.
The integrated NOVRAM permits storage of process data that is safe against power failure.

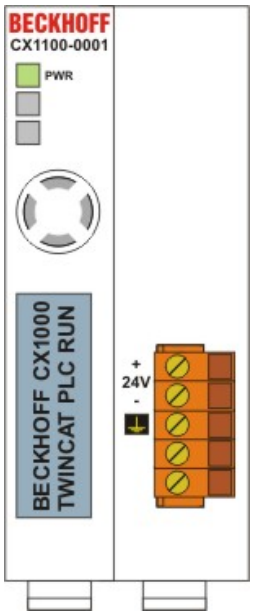


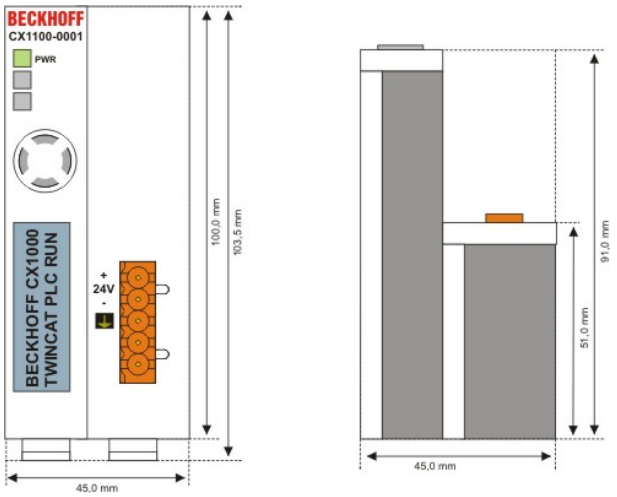
Table 1: Pin Allocation Open Style Connector:

Pin	Assignmnet
1	+24 V DC
2	0 V DC
3	GROUND
4	reserved / don't use
5	reserved / don't use

LED:

With proper connection of the power supply unit and with power supply turned on, the power LED (PWR) lights up green. In the case of a short-circuit, it lights up red.

2.7.2 Technical data CX1100-0001



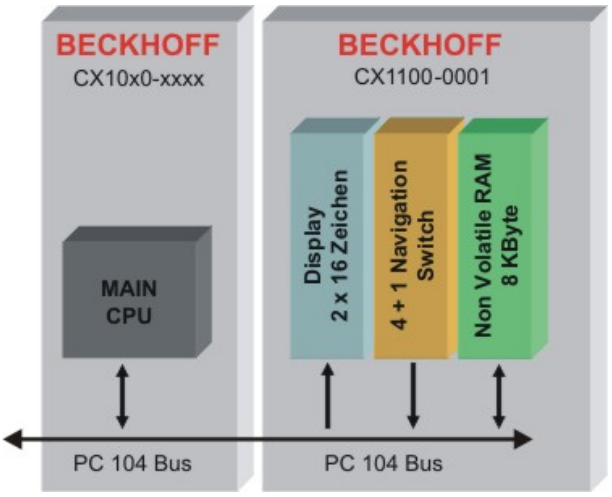
Technical data	CX1100-0001
Power supply	24 V_{DC} (-15%/+20%) To meet the UL requirements use a 4 A fuse or a power supply that has to satisfy *NEC class 2*! AWG 28-14 55°C max US LISTED Ind.Cont.Eq. 24TB — For Us/GNDs and Up/GNDp: Use 4 Amp. fuse or Class 2 power supply
Dielectric strength	500 V_{eff} (supply / internal electronics)
Max. power consumption	2.5 W
Recommended fuse at 24 V	4 A
K-bus connection	-
E-bus connection	-
IP-Link connection	-
K-bus power supply to	-
connection type	1 x Open Pluggable Connector, 5-pin
NOVRAM	8 kByte
Display	FSTN display 2 lines x 16 characters of text, illuminated
I/O-DPRAM	-
Diagnose LED	1 x PWR
Dimensions (W x H x D)	45 mm x 100 mm x 91 mm
weight	app.180 g
operating/storage temperature	0° C ... +55° C / -25° C ... +85° C
Relative humidity	95% no condensation
Vibration/shock resistance	conforms to EN 60068-2-6 / EN 60068-2-27/29
EMC resistance burst / ESD	conforms to EN 61000-6-2 / EN 61000-6-4
protection class	IP 20

2.7.3 Architecture of power supply CX1100-0001

This power supply features, except for power supply, the following functions:

1. Display 2 x 16 characters
2. 4+1 navigation switch
3. Non Volatile RAM

These functions are managed by the control program via the PC104 bus. The structure of the CX1100-0001 is shown in the following figure:



This power supply unit features only the basic functions. These functions are described in the architecture overview.

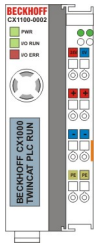
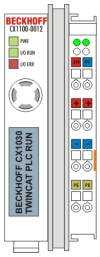
Also see about this

- Architecture of the power supply units [▶ 10]

2.8 CX1100-0002 / CX1100-0012

2.8.1 CX1100-00x2 connections

This power supply unit is equipped with an I/O interface, which permits connection of the Beckhoff Bus Terminals. The power is supplied via the upper spring-loaded terminals labelled “24V” and “0V”.
The supply voltage feeds the CX system and supplies a voltage of 24 V DC (-15 %/+20%) to the Bus Terminals via the K-Bus. The dielectric strength of the power supply unit is 500 V_{rms}. Since the K-Bus does no more than pass data on, a further power supply is necessary for the Bus Terminals. This is provided by means of the power contacts, which are not connected to the power supply.
The integrated NOVRAM permits storage of process data that is safe against power failure.

	
CX1100-0002 for CX1000, CX1010 und CX1020	CX1100-0012 for CX1030

LED:

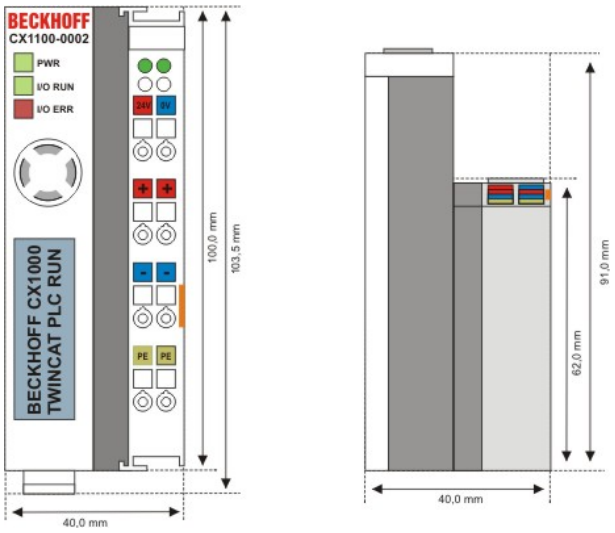
With proper connection of the power supply unit and with power supply turned on, the power LED (PWR) lights up green. In the case of a short-circuit, it lights up red.

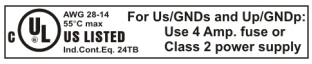
The I/O LEDs display the operation status of the Bus Terminals. Error-free start-up of the configuration is signalled by the red "I/O ERR" LED being extinguished. If the ”I/O ERR" LED blinks, an error in the area of the terminals is indicated. The error code can be determined from the frequency and number of blinks.

PE power contacts

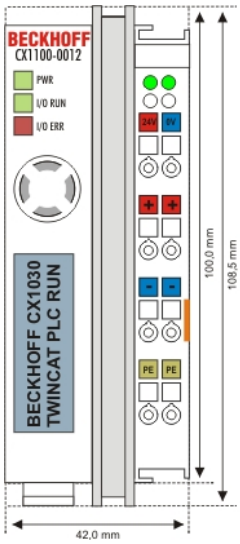
The ”PE" power contact must not be used for other potentials.

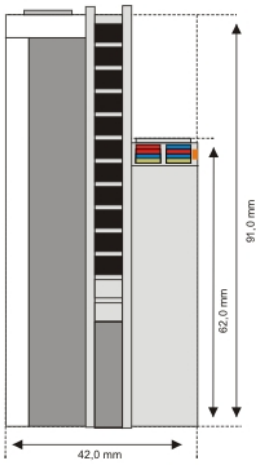
2.8.2 Technical data CX1100-0002

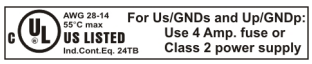


Technical data	CX1100-0002
Power supply	24 V_{DC} (-15%/+20%) To meet the UL requirements use a 4 A fuse or a power supply that has to satisfy *NEC class 2*! 
Dielectric strength	500 V_{eff} (supply / internal electronics)
Max. power consumption	3.5 W
Recommended fuse at 24 V	4 A
K-bus connection	yes (adapter terminal)
E-bus connection	-
IP-Link connection	-
K-bus power supply to	1.75 A
connection type	Cage-Clamp (adapter terminal)
NOVRAM	8 kByte
Display	FSTN display 2 lines x 16 characters of text, illuminated
I/O-DPRAM	2 kByte
Diagnose LED	1 x PWR, 1 x I/O Run, 1 x 1/O Err
Dimensions (W x H x D)	40 mm x 100 mm x 91 mm
weight	app.250 g
operating/storage temperature	0° C ... +55° C / -25° C ... +85° C
Relative humidity	95% no condensation
Vibration/shock resistance	conforms to EN 60068-2-6 / EN 60068-2-27/29
EMC resistance burst / ESD	conforms to EN 61000-6-2 / EN 61000-6-4
protection class	IP 20

2.8.3 Technical data CX1100-0012





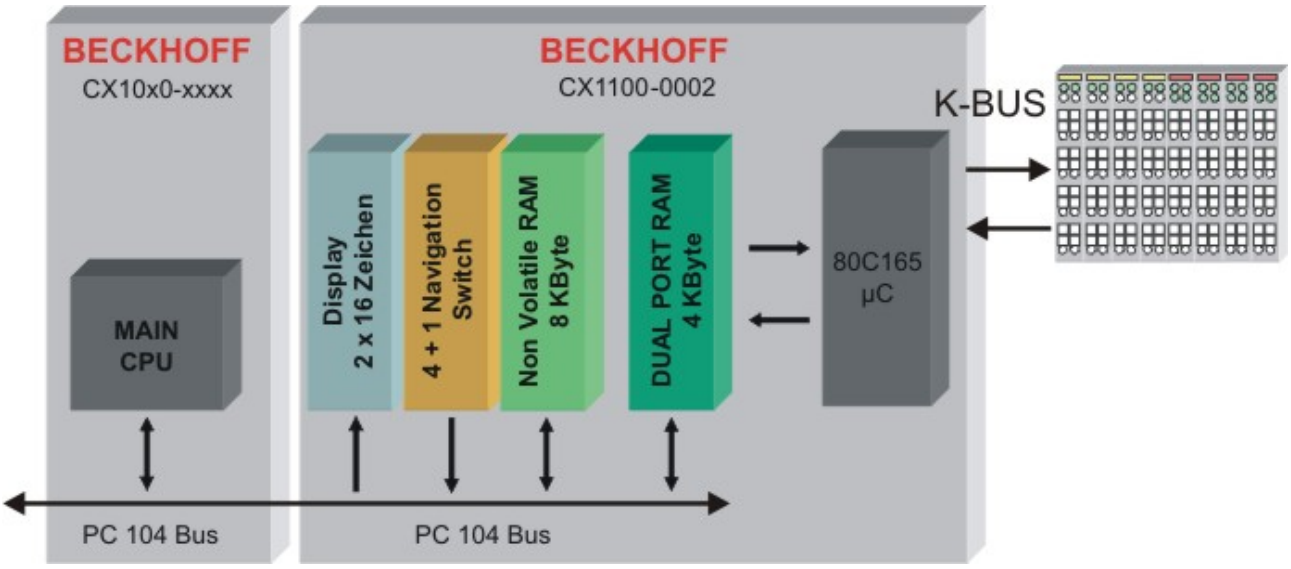
Technical data	CX1100-0012
Power supply	24 V_{DC} (-15%/+20%) To meet the UL requirements use a 4 A fuse or a power supply that has to satisfy *NEC class 2*! 
Dielectric strength	500 V_{eff} (supply / internal electronics)
Max. power consumption	3.5 W
Recommended fuse at 24 V	4 A
K-bus connection	yes (adapter terminal)
E-bus connection	-
IP-Link connection	-
K-bus power supply to	1.75 A
connection type	Cage-Clamp (adapter terminal)
NOVRAM	8 kByte
Display	FSTN display 2 lines x 16 characters of text, illuminated
I/O-DPRAM	2 kByte
Diagnose LED	1 x PWR, 1 x I/O Run, 1 x 1/O Err
Dimensions (W x H x D)	42 mm x 109 mm x 92 mm
weight	app.250 g
operating/storage temperature	0° C ... +55° C / -25° C ... +85° C
Relative humidity	95% no condensation
Vibration/shock resistance	conforms to EN 60068-2-6 / EN 60068-2-27/29
EMC resistance burst / ESD	conforms to EN 61000-6-2 / EN 61000-6-4
protection class	IP 20

2.8.4 Architecture of power supply CX1100-00x2

This power supply features, except for power supply, the following functions:

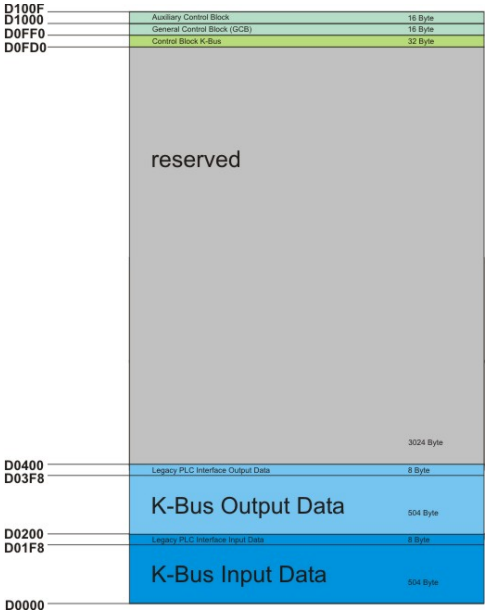
1. Display 2 x 16 characters
2. 4+1 navigation switch
3. Non Volatile RAM
4. K-bus connections

These functions are managed by the control program via the PC104 bus. The structure of the CX1100-00x2 is shown in the following figure:



This power supply unit features the basic functions. These functions are described in the architecture overview. Further the k-bus is supported. The access to the bus is managed by a 4 KB dual-ported-RAM (DPRAM). A microcontroller (80C165) manages the data transfer to the k-bus. The DPRAM is accessed by the CPU (via PC104 bus) and the microcontroller.

The following figure shows the memory setup of the DPRAM:



The memory image of the K-bus resides in the lower memory region (D000 to D0400). This region separates in input and output region. Since firmware version ≥ B3 it is possible to shift the I/O regions. In this way the process image can be adapted to the needed space. To each I/O-region the is a control block. Each block consists of 8 byte for diagnosis purpose. These regions can be shifted, too. The following table shows the structure of the interface. The offset addresses are default values.

Legacy PLC interface (inputs)	
Offset	Default
0x1F8 [2]	Diagnosis CX1100-0002 to K-Bus
0x1FA [2]	2 Byte PLC Interface from CX1100-0002 to K-Bus
0x1FC [4]	reserved
Legacy PLC interface (outputs)	
Offset	Default
0x3F8 [2]	Diagnosis K-Bus to CX1100-0002
0x3FA [2]	2 Byte PLC Interface from K-Bus to CX1100-0002
0x3FC [4]	reserved

The K-Bus Control Block (CB K-Bus)

This section describes the layout of the control block for the K-bus portion of a CX1100-0002 or CX1100-0003. This control block is located in the memory just below the General Control Block GCB.

CB K-Bus		
Offset		**Default**
0xFD0[2]	K-Bus 2 byte plc interface to CX1100-0002/3	
0xFD2[2]	K-Bus 2 byte plc interface from CX1100-0002/3	
0xFD4[2]	K-Bus diagnosis to CX1100-0002/3	
0xFD6[2]	K-Bus diagnosis from CX1100-0002/3	
0xFD8	K-Bus service request bitfield	
0xFD9	K-Bus service response bitfield	
0xFDA	K-Bus error code	
0xFDB	K-Bus error argument	
0xFDC[2]	K-Bus base ptr Inputs	0x000
0xFDE[2]	K-Bus base ptr Outputs	0x200
0xFE0-0xFE1	K-Bus cycle count	
0xFE2-0xFE3	K-Bus cycle time [µs]	
0xFE4	K-Bus bus status	
0xFE5-0xFEE	Reserved	
0xFEF	Retry counter	

K-Bus 2 byte plc interface to CX1100-0002/3 / K-Bus 2 byte plc interface from CX1100-0002/3

These two bytes for each direction - from the main CPU to CX1100 and back - special communication with the register model of the I/O microcontroller. Through this interface, a communication to K-Bus terminals can take place. The so called register model description can be found in the hardware description manuals of the terminals and bus couplers. This communication is typically used for extended diagnosis or configuration of terminals if they need to deviate from the delivery standard, e.g. changing the baud rate for RS232-terminals or gain/offset values with analog terminals.

K-Bus diagnosis to CX1100-0002/3 / K-Bus diagnosis from CX1100-0002/3

With these two bytes in each direction it is possible to retrieve diagnostic information from the attached terminals. Since the same diagnostic information is reflected in the process image input area per each terminals, there is in general no need to use this interface.

K-Bus service request bitfield / K-Bus service response bitfield

IThese two bytes contain a sequence of bits, by which certain service functions may be executed. The service function is invoked by setting the appropriate request bit, the controller executes and sets the response bit. Before the same function can be invoked again, the request bit must be set to zero and wait until the response bit is also set to zero. An execution error is signaled by raising response bit 7.

Bitfeld	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Request	-	-	-	-	-	-	Free Run	Reset Bus
Response	Error	-	-	-	-	-	Free Run Active	Reset Done

Reset Bus:

with this bit, a reset of the K-Bus may be performed. This is necessary after the occurrence of an error (detected by examination of the "Processdata error"-byte in the GCB) e.g. after a terminal has been pulled out. After performing the K-Bus reset, the error code and error argument may be read from the locations "K-Bus error code" and "K-Bus error argument" in the CB K-Bus. If there is no error after reset, the K-Bus is ready for operation again.

Free Run:

not implemented. Reserved for future use..

K-Bus error code K-Bus error argument

If the K-Bus operation fails (bad terminal, missing end-terminal, severe EMC interference), an error flag is raised in the GCB and after a K-Bus reset, these two bytes contain the error code and error argument of the occurred fault - if it still persists.

K-Bus base ptr Inputs / K-Bus base ptr Outputs

These two byte values contain the starting offset for the K-Bus input and output process image area. In most cases the default offsets should be left unchanged. When changing one of these offsets, a "Remap" or "Reset node" in the GCB service is needed. Also care must be taken not to overlap with the IP-Link process image area, because in the CB IP-Link the offset pointers for these areas may also be changed. The Beckhoff automation software TwinCAT makes use of this base ptr feature and compacts the I/O images in the best way possible.

K-Bus cycle count

This two-byte counter is incremented with each I/O-cycle.

K-Bus cycle time

This is the time elapsed between the initiation and termination of an I/O process image update (K-Bus + IP-Link). The time is recorded in units of microseconds and starts with writing a new cycle request to the field "PD cycle request" and it stops with the termination response in the field "PD cycle ready", in case of CX1100-0002. In case of CX1100-0003, this time reflects only the K-Bus portion of the total I/O time.

K-Bus bus status

This byte value can take only two states:

1. Byte = 0 → K-bus is ok
2. Byte ≠ 0 → K-bus fault

This information is also reflected in the "Processdata error" field (bit0) of the GCB.

Retry counter

This is a retry counter which is incremented each time the microcontroller needs to redo a cycle because of a communication error. This counter can be used for judgment of the K-Bus signal quality.

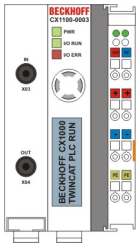
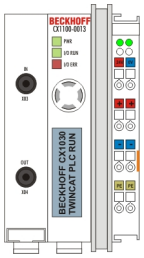
Also see about this

Architecture of the power supply units [▶ 10]

2.9 CX1100-0003 / CX1100-0013

2.9.1 CX1100-00x3 connections

This power supply unit permits not only the connection of the Beckhoff Bus Terminals, but also the serial connection of the Beckhoff fieldbus box modules of the type extension box IExxxx. The power is supplied via the upper spring-loaded terminals labeled “24V” and “0V”.
The supply voltage feeds the CX system and, over the K-Bus, the Bus Terminals. Since the K-Bus does no more than pass data on, a further power supply is necessary for the Bus Terminals. This is provided by means of the power contacts, which are not connected to the power supply.

	
CX1100-0003 for CX1000, CX1010 und CX1020	CX1100-0013 for CX1030

Fieldbus connection:

Plug the IP link connector into the respective connections, i.e. one fibre-optic cable each into IN (x03) and OUT (x04). You then connect the other end with the corresponding IP link interface of the extension box. The connection must be made so that the output of the fieldbus connection is connected to the input of the extension box and vice versa.

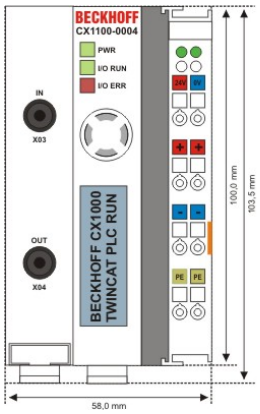
LED:

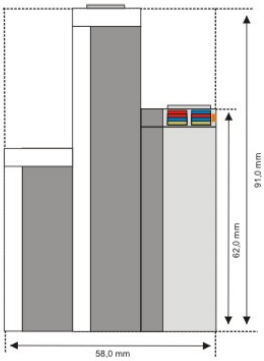
With proper connection of the power supply unit and with power supply turned on, the power LED (PWR) lights up green. In the case of a short-circuit, it lights up red. The I/O LEDs display the operation status of the Bus Terminals. Error-free start-up of the configuration is signaled by the red "I/O ERR" LED being extinguished. If the ”I/O ERR" LED blinks, an error in the area of the terminals is indicated. The error code can be determined from the frequency and number of blinks.

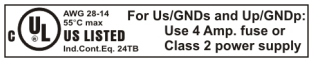
PE power contacts

The ”PE" power contact must not be used for other potentials.

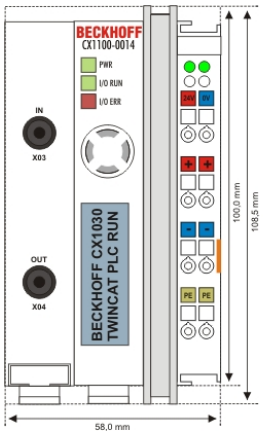
2.9.2 Technical data CX1100-0003

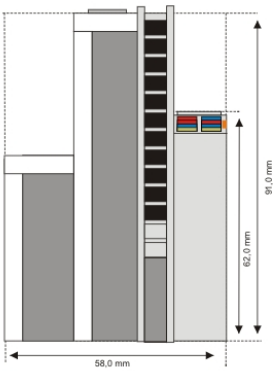




Technical data	CX1100-0003
Power supply	24 V_{DC} (-15%/+20%) To meet the UL requirements use a 4 A fuse or a power supply that has to satisfy *NEC class 2*! 
Dielectric strength	500 V_{eff} (supply / internal electronics)
Max. power consumption	4 W
Recommended fuse at 24 V	4 A
K-bus connection	yes (adapter terminal)
E-bus connection	-
IP-Link connection	yes
K-bus power supply to	1.75 A
connection type	Cage-Clamp (adapter terminal)
NOVRAM	8 kByte
Display	FSTN display 2 lines x 16 characters of text, illuminated
I/O-DPRAM	4 kByte
Diagnose LED	1 x PWR, 1 x I/O Run, 1 x 1/O Err
Dimensions (W x H x D)	58 mm x 100 mm x 91 mm
weight	app.350 g
operating/storage temperature	0° C ... +55° C / -25° C ... +85° C
Relative humidity	95% no condensation
Vibration/shock resistance	conforms to EN 60068-2-6 / EN 60068-2-27/29
EMC resistance burst / ESD	conforms to EN 61000-6-2 / EN 61000-6-4
protection class	IP 20

2.9.3 Technical data CX1100-0013





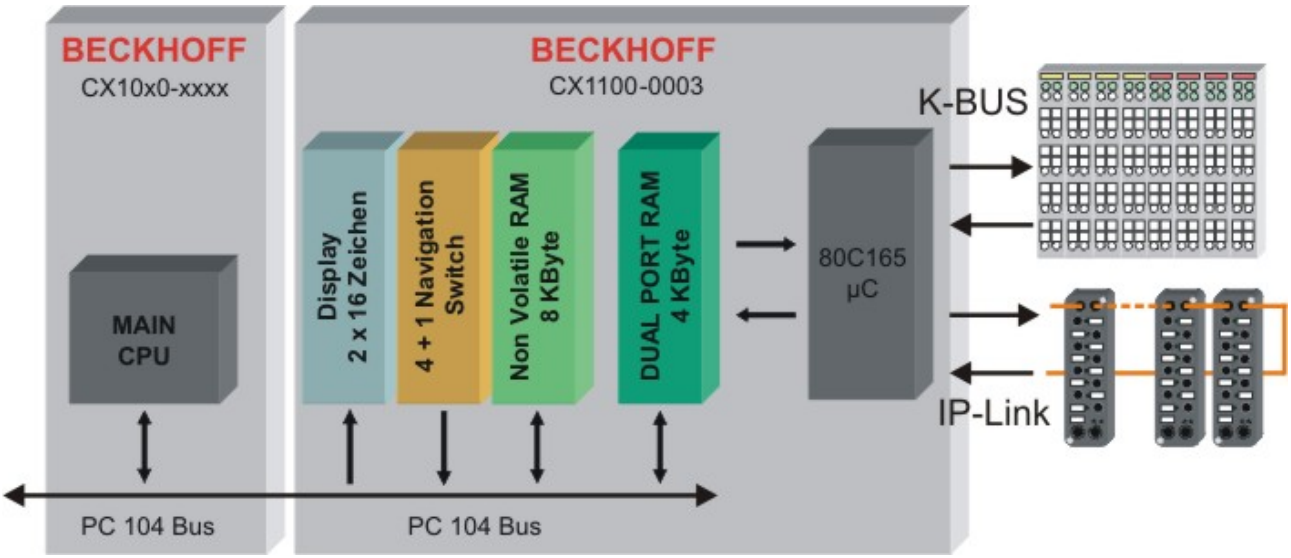
Technical data	CX1100-0013
Power supply	24 V_{DC} (-15%/+20%) To meet the UL requirements use a 4 A fuse or a power supply that has to satisfy *NEC class 2*! AWG 28-14 55°C max US LISTED Ind.Cont.Eq. 24TB — For Us/GNDs and Up/GNDp: Use 4 Amp. fuse or Class 2 power supply
Dielectric strength	500 V_{eff} (supply / internal electronics)
Max. power consumption	4 W
Recommended fuse at 24 V	4 A
K-bus connection	yes (adapter terminal)
E-bus connection	-
IP-Link connection	yes
K-bus power supply to	1.75 A
connection type	Cage-Clamp (adapter terminal)
NOVRAM	8 kByte
Display	FSTN display 2 lines x 16 characters of text, illuminated
I/O-DPRAM	4 kByte
Diagnose LED	1 x PWR, 1 x I/O Run, 1 x 1/O Err
Dimensions (W x H x D)	58 mm x 109 mm x 92 mm
weight	app.350 g
operating/storage temperature	0° C ... +55° C / -25° C ... +85° C
Relative humidity	95% no condensation
Vibration/shock resistance	conforms to EN 60068-2-6 / EN 60068-2-27/29
EMC resistance burst / ESD	conforms to EN 61000-6-2 / EN 61000-6-4
protection class	IP 20

2.9.4 Architecture of power supply CX1100-00x3

This power supply features, except for power supply, the following functions:

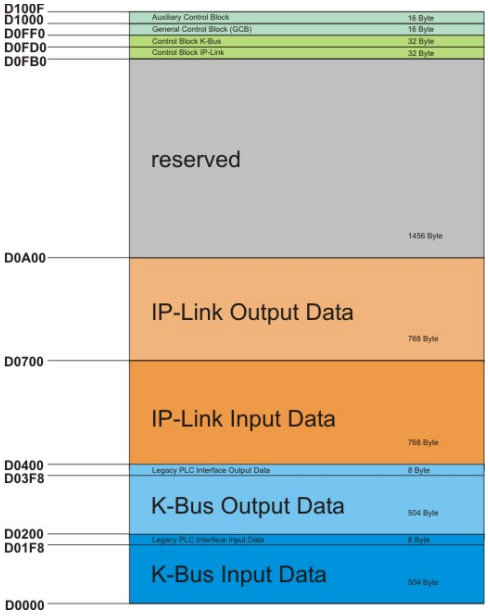
1. Display 2 x 16 characters
2. 4+1 navigation switch
3. Non Volatile RAM
4. K-bus connections
5. IP-Link bus connection

These functions are managed by the control program via the PC104 bus. The structure of the CX1100-00x3 is shown in the following figure:



This power supply unit features the basic functions. These functions are described in the architecture overview. Further the k-bus is supported. This interface is described in the architecture of the CX1100-0002 unit. This unit also features the access to the IP-Link bus. A fiber optics ring can be connected to the power supply The access is realized by a 4 KB dual-ported RAM. A microcontroller (80C165) manages the data transfer to the IP-Link-bus. The DPRAM is accessed by the CPU (via PC104 bus) and the microcontroller.

The following figure shows the memory setup of the DPRAM:



The memory image of the IP-Link bus resides in the lower memory region (D400 to D0A00). This region separates in input and output region. Since firmware version ≥ B3 it is possible to shift the I/O regions. In this way the process image can be adapted to the needed space. Each block jhas a size of 768 bytes. The following table shows the structure of the interface. The offset addresses are default values.

The IP-Link Control Block (CB IP-Link)

This section describes the layout of the control block for the IP-Link bus of CX1100-0003. This control block is located in the memory just below the I/O region of the K-bus interface.

CB IP-Link		
Offset		**Default**
0xFB0[2]	IPL 2 byte plc interface to CX1100-0002/3	
0xFB2[2]	IPL 2 byte plc interface from CX1100-0002/3	
0xFB4[2]	IPL diagnosis to CX1100-0002/3	
0xFB6[2]	IPL diagnosis from CX1100-0002/3	
0xFB8	IPL service request bitfield	
0xFB9	IPL service response bitfield	
0xFBA	IPL error code	
0xFBB	IPL error argument	
0xFBC[2]	IPL base ptr Inputs	0x400
0xFBE[2]	IPL base ptr Outputs	0x700
0xFC0-0xFC1	IPL cycle count	
0xFC2-0xFC3	IPL cycle time [µs]	
0xFC4	IPL bus status	
0xFC5-0xFCE	Reserved	
0xFCF	Retry counter	

IP-Link 2 byte plc interface to CX1100-0003 / IP-Link 2 byte plc interface from CX1100-0003

These two bytes for each direction - from the main CPU to CX1100 and back - special communication with the register model of the I/O microcontroller. Through this interface, a communication to K-Bus terminals can take place. The so called register model description can be found in the hardware description manuals of the terminals and bus couplers. This communication is typically used for extended diagnosis or configuration of terminals if they need to deviate from the delivery standard, e.g. changing the baud rate for RS232-terminals or gain/offset values with analog terminals.

IP-Link diagnosis to CX1100-0003 / IP-Link diagnosis from CX1100-0003

With these two bytes in each direction it is possible to retrieve diagnostic information from the attached terminals. Since the same diagnostic information is reflected in the process image input area per each terminals, there is in general no need to use this interface.

IP-Link service request bitfield / IP-Link service response bitfield

IThese two bytes contain a sequence of bits, by which certain service functions may be executed. The service function is invoked by setting the appropriate request bit, the controller executes and sets the response bit. Before the same function can be invoked again, the request bit must be set to zero and wait until the response bit is also set to zero. An execution error is signaled by raising response bit 7.

Bitfeld	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Request	-	-	-	-	-	-	Free Run	Reset Bus
Response	Error	-	-	-	-	-	Free Run Active	Reset Done

Reset Bus:

with this bit, a reset of the K-Bus may be performed. This is necessary after the occurrence of an error (detected by examination of the "Processdata error"-byte in the GCB) e.g. after a terminal has been pulled out. After performing the K-Bus reset, the error code and error argument may be read from the locations "K-Bus error code" and "K-Bus error argument" in the CB K-Bus. If there is no error after reset, the K-Bus is ready for operation again.

Free Run:

not implemented. Reserved for future use..

IP-Link error code K-Bus error argument

If the K-Bus operation fails (bad terminal, missing end-terminal, severe EMC interference), an error flag is raised in the GCB and after a K-Bus reset, these two bytes contain the error code and error argument of the occurred fault - if it still persists.

IP-Link base ptr Inputs / K-Bus base ptr Outputs

These two byte values contain the starting offset for the K-Bus input and output process image area. In most cases the default offsets should be left unchanged. When changing one of these offsets, a "Remap" or "Reset node" in the GCB service is needed. Also care must be taken not to overlap with the IP-Link process image area, because in the CB IP-Link the offset pointers for these areas may also be changed. The Beckhoff automation software TwinCAT makes use of this base ptr feature and compacts the I/O images in the best way possible.

IP-Link cycle count

This two-byte counter is incremented with each I/O-cycle.

IP-Link cycle time

This is the time elapsed between the initiation and termination of an I/O process image update (K-Bus + IP-Link). The time is recorded in units of microseconds and starts with writing a new cycle request to the field "PD cycle request" and it stops with the termination response in the field "PD cycle ready", in case of CX1100-0002. In case of CX1100-0003, this time reflects only the K-Bus portion of the total I/O time.

IP-Link bus status

This byte value can take only two states:

1. Byte = 0 → K-bus is ok
2. Byte ≠ 0 → K-bus fault

This information is also reflected in the "Processdata error" field (bit0) of the GCB.

Retry counter

This is a retry counter which is incremented each time the microcontroller needs to redo a cycle because of a communication error. This counter can be used for judgment of the K-Bus signal quality.

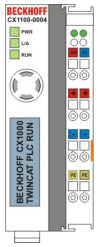
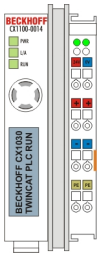
Also see about this

Architecture of the power supply units [▶ 10]

2.10 CX1100-0004 / CX1100-0014

2.10.1 CX1100-00x4 connections

This power supply unit is equipped with an I/O interface, which permits connection of the Beckhoff Bus Terminals. The power is supplied via the upper spring-loaded terminals labeled “24V” and “0V”.
The supply voltage feeds the CX system and supplies a voltage of 24 V DC (-15 %/+20%) to the Bus Terminals via the E-Bus. The dielectric strength of the power supply unit is 500 V_{rms}. Since the E-Bus does no more than pass data on, a further power supply is necessary for the Bus Terminals. This is provided by means of the power contacts, which are not connected to the power supply.
The integrated NOVRAM permits storage of process data that is safe against power failure.

	
CX1100-0004 for CX1000, CX1010 und CX1020	CX1100-0014 for CX1030

LED:

With proper connection of the power supply unit and with power supply turned on, the power LED (PWR) lights up green. In the case of a short-circuit, it lights up red.

PE power contacts

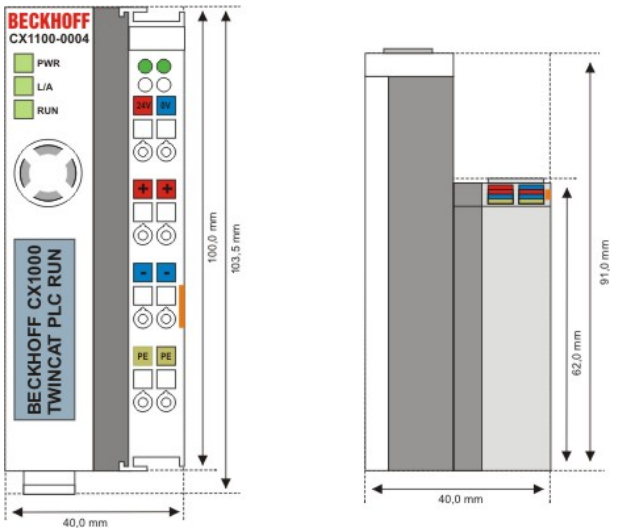
The ”PE" power contact must not be used for other potentials.

Note	This power supply is designed for use with CX1020 systems only. Operation with CX1000 systems is not possible because the EtherCAT protocol is not implemented / designed in the hardware of the CX1000 systems.

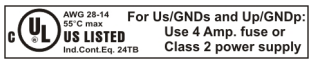
Note	The power supply CX1100-0004 can only be used instead and not simultaneously with system interface CX1020-N060

Attention	It is important to keep attention to the hardware revision of the power supply. Power supplies with a hardware revision > 2.0 only work with CX1020 systems with a hardware revision > 2.1 !

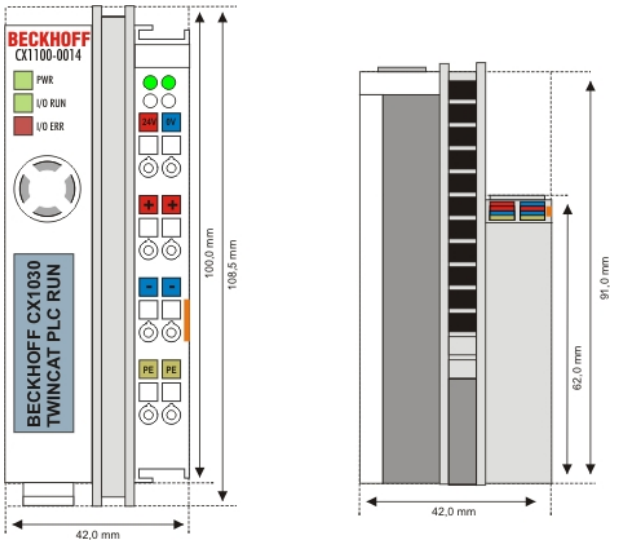
2.10.2 Technical data CX1100-0004



With the CX1100-0004 power supply EtherCAT Terminals can be connected to the CX1020-System. With CX1100-0004 the I/O data are stored directly in the main memory of the CPU; a DPRAM is no longer required. The CX1100-0004 power supply unit for EtherCAT Terminals can only be connected in conjunction with the basic CPU modules CX1010/CX1020/CX1030. The combination with CX1000/CX1001 is **not** possible.

Technical data	CX1100-0004
Power supply	24 V_{DC} (-15%/+20%) To meet the UL requirements use a 4 A fuse or a power supply that has to satisfy *NEC class 2*! 
Dielectric strength	500 V_{eff} (supply / internal electronics)
Max. power consumption	3.5 W
Recommended fuse at 24 V	4 A
K-bus connection	-
E-bus connection	yes (adapter terminal)
IP-Link connection	-
E-bus power supply to	2 A
connection type	Cage-Clamp (adapter terminal)
NOVRAM	8 kByte
Display	FSTN display 2 lines x 16 characters of text, illuminated
I/O-DPRAM	-
Diagnose LED	1 x PWR, 1 x L/A Run, 1 x RUN
Dimensions (W x H x D)	40 mm x 100 mm x 91 mm
weight	app.250 g
operating/storage temperature	0° C ... +55° C / -25° C ... +85° C
Relative humidity	95% no condensation
Vibration/shock resistance	conforms to EN 60068-2-6 / EN 60068-2-27/29
EMC resistance burst / ESD	conforms to EN 61000-6-2 / EN 61000-6-4
protection class	IP 20

2.10.3 Technical data CX1100-0014



The CX1100-0014 power supply is designed for CX1030.

With the CX1100-0014 power supply EtherCAT Terminals can be connected to the CX10x0-System. With CX1100-0004 the I/O data are stored directly in the main memory of the CPU; a DPRAM is no longer required. The CX1100-0014 power supply unit for EtherCAT Terminals can *not* be connected in conjunction with the basic CX1000 CPU module.

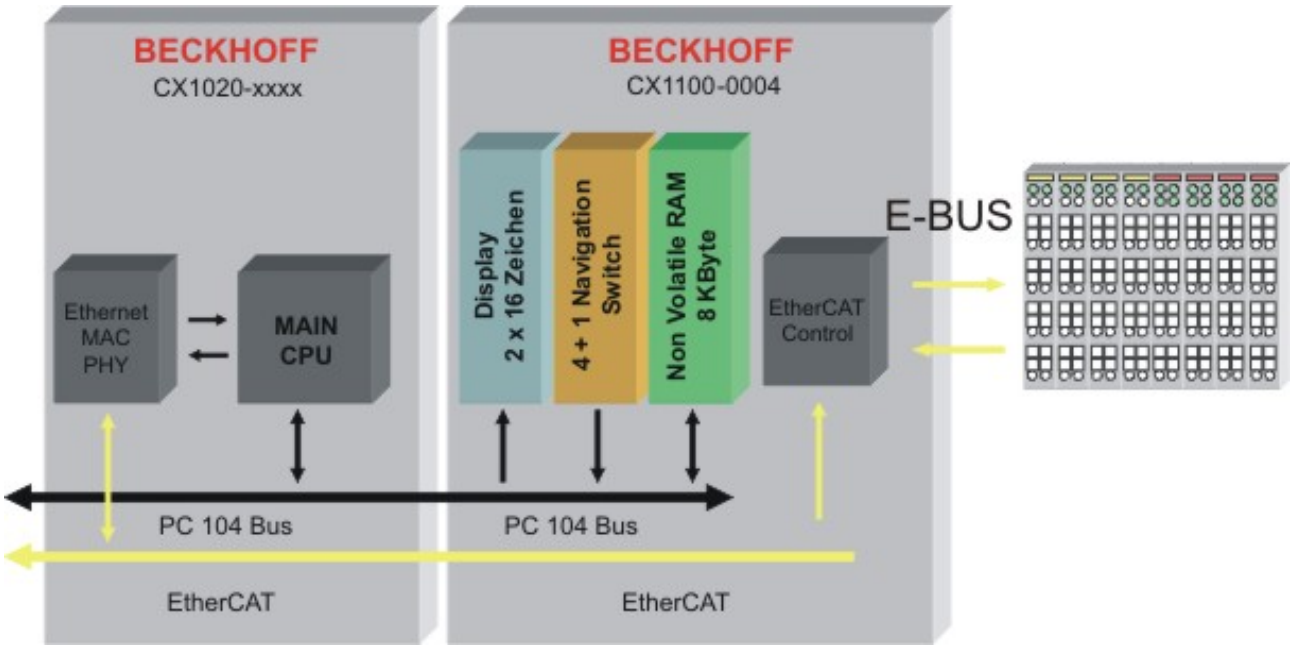
Technical data	CX1100-0014
Power supply	24 V_{DC} (-15%/+20%) To meet the UL requirements use a 4 A fuse or a power supply that has to satisfy *NEC class 2*! AWG 28-14 55°C max US LISTED Ind.Cont.Eq. 24TB For Us/GNDs and Up/GNDp: Use 4 Amp. fuse or Class 2 power supply
Dielectric strength	500 V_{eff} (supply / internal electronics)
Max. power consumption	3.5 W
Recommended fuse at 24 V	4 A
K-bus connection	-
E-bus connection	yes (adapter terminal)
IP-Link connection	-
E-bus power supply to	2 A
connection type	Cage-Clamp (adapter terminal)
NOVRAM	8 kByte
Display	FSTN display 2 lines x 16 characters of text, illuminated
I/O-DPRAM	-
Diagnose LED	1 x PWR, 1 x L/A Run, 1 x RUN
Dimensions (W x H x D)	42 mm x 109 mm x 92 mm
weight	app.250 g
operating/storage temperature	0° C ... +55° C / -25° C ... +85° C
Relative humidity	95% no condensation
Vibration/shock resistance	conforms to EN 60068-2-6 / EN 60068-2-27/29
EMC resistance burst / ESD	conforms to EN 61000-6-2 / EN 61000-6-4
protection class	IP 20

2.10.4 Architecture of power supply CX1100-00x4

This power supply features, except for power supply, the following functions:

1. Display 2 x 16 characters
2. 4+1 navigation switch
3. Non Volatile RAM
4. E-bus connection

These functions are managed by the control program via the PC104 bus. The structure of the CX1100-0004 is shown in the following figure:



This power supply unit features the basic functions. These functions are described in the architecture overview. Further the E-bus is supported. The access to the bus is transparent for the user. The unit transfers the signals from EtherCAT-bus to E-bus. The control is managed by the CPU. The E-bus terminals are accessed by TwinCAT similar to the K-bus terminals.

Also see about this

- Architecture of the power supply units [▶ 10]

3 Transport

3.1 Unpacking, installation and transport

The specified storage conditions must be adhered to (see "Technical data").

Dimensions and weight of the individual modules:

Module	CX1100-0001	CX1100-0002	CX1100-0003	CX1100-0004
Dimensions (W x H x D)	45 mm x 100 mm x 91 mm	40 mm x 100 mm x 91 mm	58 mm x 100 mm x 91 mm	40 mm x 100 mm x 91 mm
Weight	app. 180 g	app. 209 g	app. 260g	app.193 g

Module	CX1100-0012	CX1100-0013	CX1100-0014
Dimensions (W x H x D)	40 mm x 100 mm x 91 mm	58 mm x 100 mm x 91 mm	40 mm x 100 mm x 91 mm
Weight	app. 240 g	app. 235 g	app. 235 g

Unpacking

Proceed as follows to unpack the unit:
1. Remove packaging.
2. Do not discard the original packaging. Keep it for future relocation.
3. Check the delivery for completeness by comparing it with your order.
4. Please keep the associated paperwork. It contains important information for handling the unit.
5. Check the contents for visible shipping damage.
6. If you notice any shipping damage or inconsistencies between the contents and your order, you should notify Beckhoff Service.

 **Attention**	Danger of damage to the unit!

During transport in cold conditions, or if the unit is subjected to extreme temperature swings, condensation on and inside the unit must be avoided.
Prior to operation, the unit must be allowed to slowly adjust to room temperature. Should condensation occur, a delay time of approximately 12 hours must be allowed before the unit is switched on.

Installation

The devices are designed for installation in control cabinets. You will find installation instructions in the chapter mechanical mounting.

Shipping and relocation

Despite the robust design of the unit, the components are sensitive to strong vibrations and impacts. During transport, your computer should therefore be protected from excessive mechanical stress. Therefore, please use the original packaging.

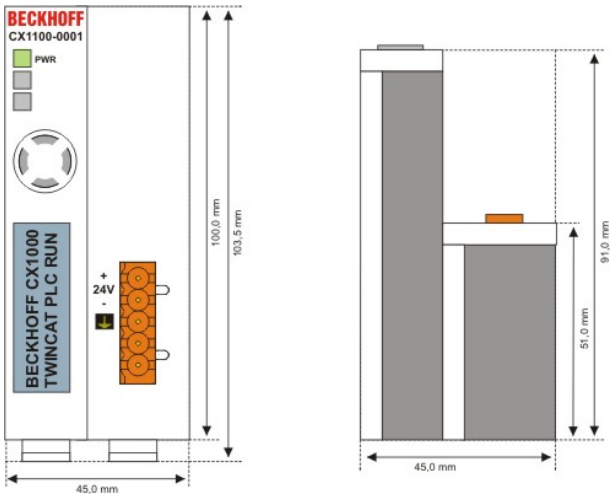
4 Fitting and wiring

4.1 Mechanical assembly

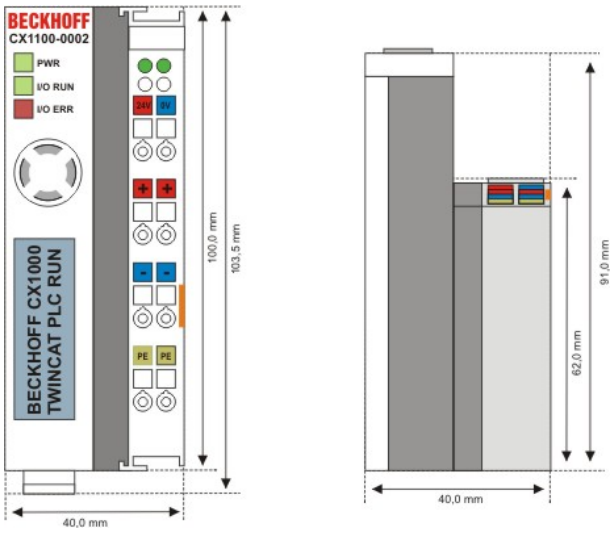
4.1.1 Dimensions

The CX family product range is characterized by small overall installed size and high modularity. For project planning purposes, a CPU module, a power supply unit and the associated system interfaces and fieldbus interfaces have to be provided. The overall width of the application is made up of the individual modules. With a height of 100 mm, the module dimensions exactly match those of the Beckhoff Bus Terminals. Together with the lowered connector surfaces, this means that it can be used in a standard terminal box with a height of 120 mm.

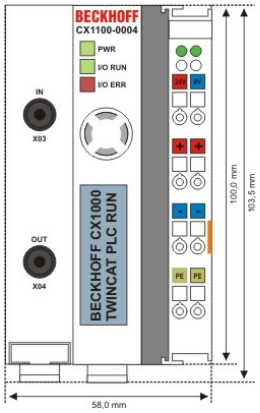
CX1100-0001:

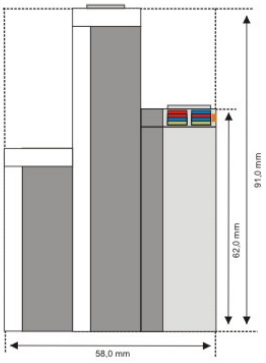


CX1100-0002:

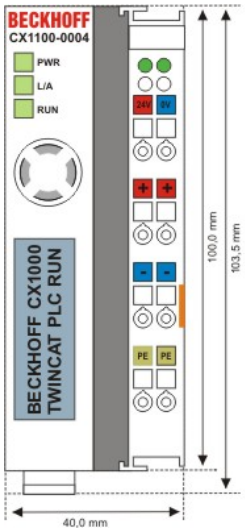


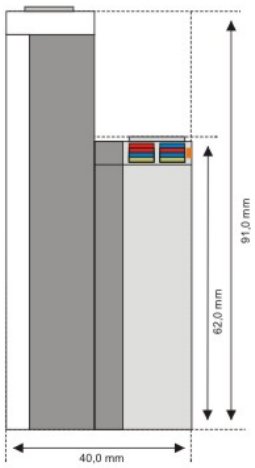
CX1100-0003:



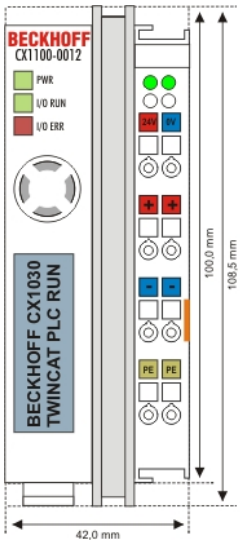


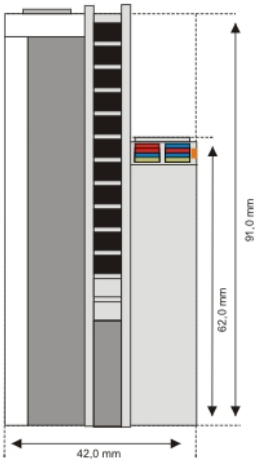
CX1100-0004:



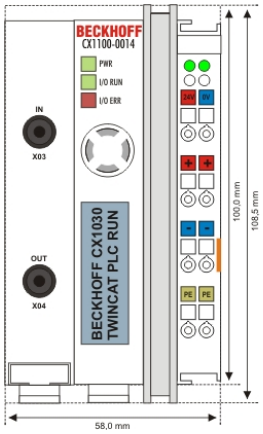


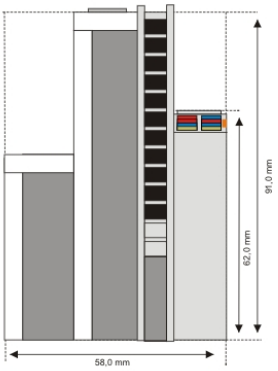
CX1100-0012:



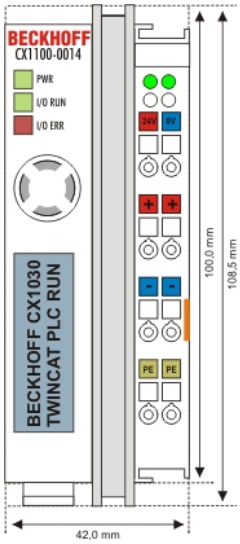


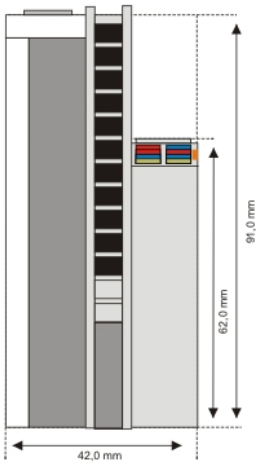
CX1100-0013:





CX1100-0014:

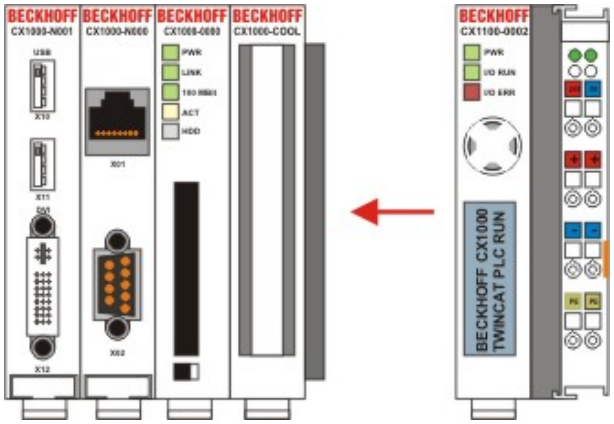




4.1.2 Mechanical assembly of the basic module

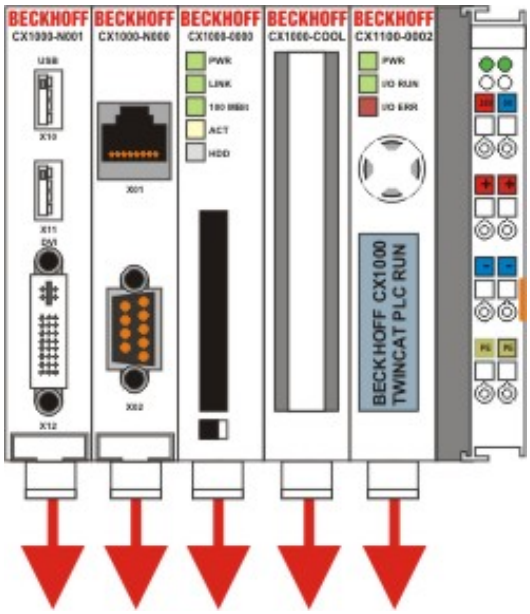
Assembly of the CPU and the power supply unit

The individual modules are simply plugged together. The PC104 connector plugs should be handled carefully in order to avoid damage. When correctly assembled, no significant gap can be seen between the attached housings.

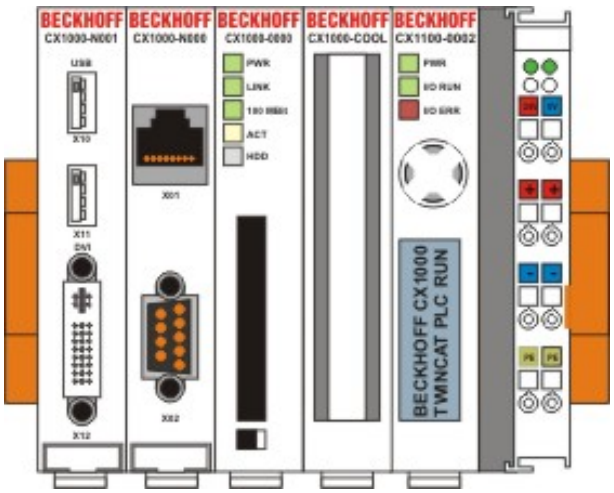


Engaging on the top-hat rail

On the bottom of the modules, there is a white tension strap, which is connected with a latching mechanism. These tension straps must be pulled down before attaching to the top-hat rail. This can be done using an ordinary screwdriver and a slight turn.



Then fix the CX1020 block on the top hat-rail using the latching straps. You should hear a soft click.



Attention	Do not force the module or apply excessive pressure!

Only apply pressure at insensitive points of the housing (edges). Never apply pressure on the display, the buttons or movable parts of the CX10x0 system. After successful latching on the top-hat rail the straps should be pushed back to their original position.

At least the power connections must be installed. The upper connections "24v" and "0V" must be connected to power supply. If the power supply CX1100-0001 is used the power supply is connected via the 5-pin open style connector. (see connections / wiring)

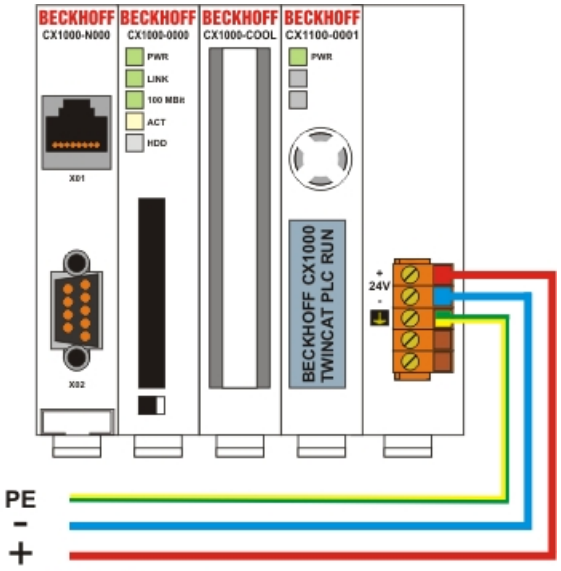
4.2 Commissioning

4.2.1 Electrical connections

The power connections for the power supplies slightly differs. All units are powers by 24 V DC. A tolerance of -15% u to +20 % is possible. The ground connection has to be installed, too. The following figures show the different connection variations.

CX1100-0001 connections

This power supply unit has no I/O interface. Though it is connected via a 5-pin "Open Pluggable Connector". In older versions of the unit the lower inputs are labeled with UPS+/-. These inputs are not in use and must not be connected.

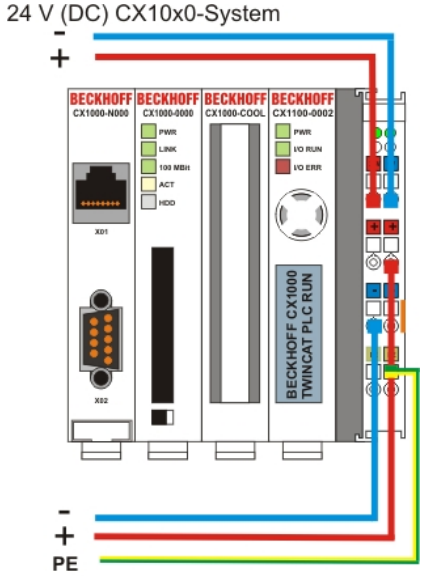


24 V (DC) CX10x0-System

CX1100-00x2 connections

This power supply unit has a k-bus interface. The k-bus will be connected separately to the power supply. It is possible to disable control and bus electronic separately.

24 V (DC) CX10x0-System

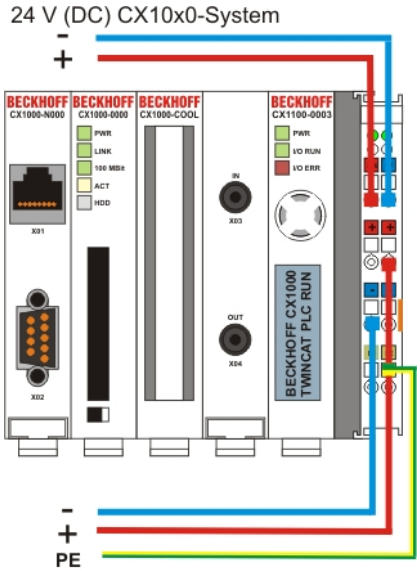


24 V (DC) K-Bus

CX1100-00x3 connections

This power supply unit has also a k-bus interface. Additional it has an IP-Link interface. The power supply is equal to CX1100-0002.

24 V (DC) CX10x0-System

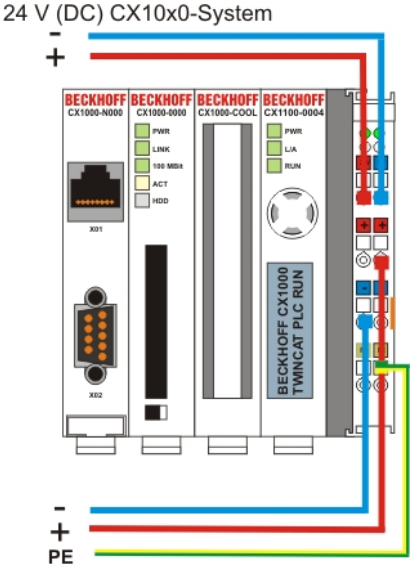


24 V (DC) K-Bus

CX1100-00x4 connections

This power supply unit was especially designed to connect E-bus terminal to the CX1020-system. The upper connections supply the CX-System and the E-bus. The lower power connections can be connected to +24V.

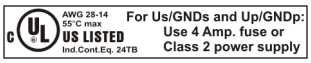
24 V (DC) CX10x0-System



24 V (DC) E-Bus

UL requirements

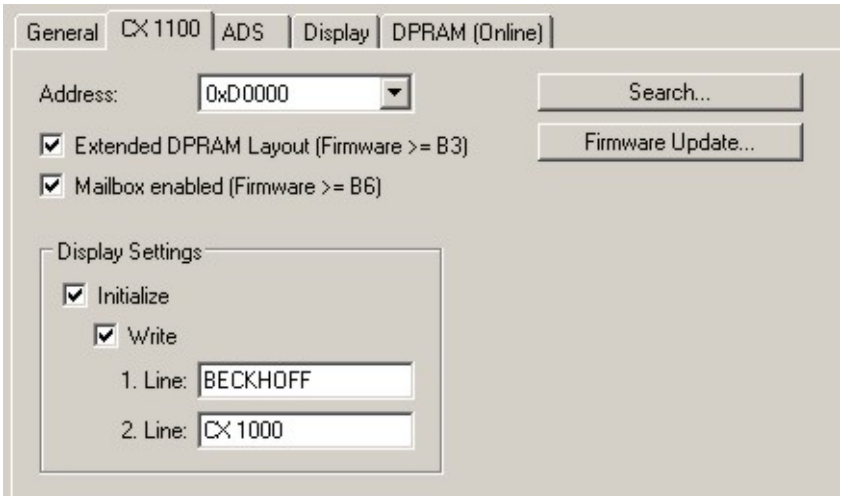
DANGER	**Art und Quelle der Gefahr** • by a 24 V_{DC} supply voltage, supplied by an isolating source and protected by means of a fuse (in accordance with UL248), rated maximum 4 Amp. • by a 24 V_{DC} power source, that has to satisfy *NEC class 2*. A *NEC class 2* power supply shall not be connected in series or parallel with another (class 2) power source!



5 Error handling and diagnostics

5.1 Terminal Bus Analysis in PLC-Program

To analyze the terminal bus (K-Bus and IP-Link) the programmer can access the registers described in the architecture. The access to the PLC-program is realized via TwinCAT. To have the access to the necessary registers the extended DPRAM model has to be activated (only in Firmware > B3). The registers are described in the architecture of the terminal bus connectors.



Though the handling is identical for both sub busses the explaination is done generally.

For analysis four signals / variables are used:

- BusState (describes the state of the bus: 0 -> no error, 1 -> bus error)
- ErrorCode (same error code as the LED blink code)
- ErrorArg (same argument code LED blink code)
- Request[0] (output to request error codes / reset bus)

In the PLC program some external variables must be defined :

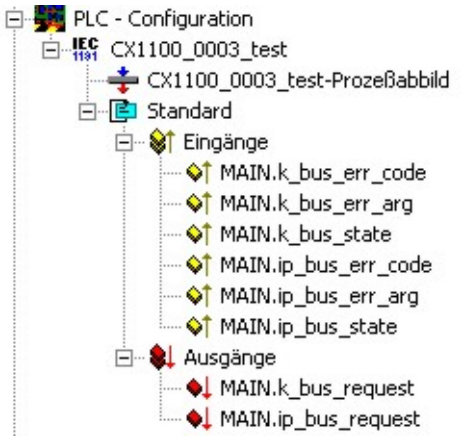
```
VAR

    k_bus_request AT %QX0.0     : BOOL;

    k_bus_err_code AT %IB0  : USINT;
    k_bus_err_arg AT %IB1   : USINT;
    k_bus_state AT %IB2     : USINT;


    ip_bus_request AT %QX0.1    : BOOL;

    ip_bus_err_code AT %IB3     : USINT;
    ip_bus_err_arg AT %IB4  : USINT;
    ip_bus_state AT %IB5    : USINT;

END_VAR
```

In the PLC program the analysis can be done as follows: (this is only pseudo code)

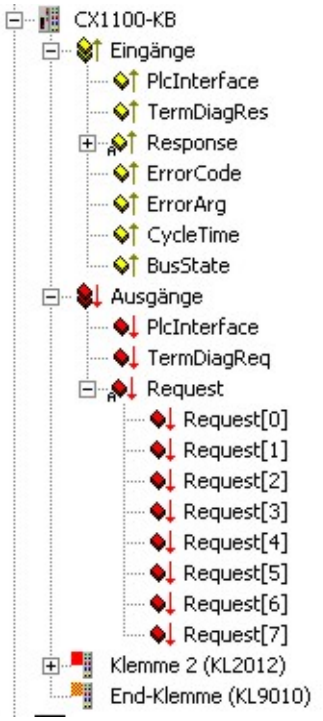
```
....

IF k_bus_state = 1       THEN       (* an error occured on K-Bus*)

   k_bus_request := TRUE;           (* request vaules for ErrCode and ErrArg *)

   CASE k_bus_err_code OF
     0 : return;            (* should not happen, though an error occured *)
     1 : CASE k_bus_arg OF
      0 : report error;     (* EEPROM checksum error *)
      1 : report error;     (* overflow in code buffer *)
```

```
      2 : report error;      (* unknown datatype *)
    END_CASE;
     2 : CASE k_bus_arg OF
      0 : report error;      (* programmed configuration, wrong table entry *)
      ELSE report error;     (* wrong table entry *)
    END_CASE;
     3 : report error        (* K-Bus command error *)
     4 : CASE k_bus_arg OF
      0 : report error;      (* break after power supply *)
      ELSE report error;     (* break after terminal 'k_bus_arg' *)
    END_CASE;
     5 : report error        (* K-Bus-error during register-communication with termi-
nal 'k_bus_arg' *)
     9 : CASE k_bus_arg OF
      0 : report error;      (* checksum error in program flash *)
      ELSE report error;     (* terminal 'k_bus_arg' does not exist in boot configuration *)
    END_CASE;
    14 : report error        (* 'k_bus_arg'-th terminal has wrong format *)
    15 : report error        (* wrong number of bus terminals *)
    16 : report error        (* length of K-Bus data is invalid *)
   END_CASE

   k_bus_request := TRUE;           (* reset bus, if reason for error is re-
moved, bus starts again *)

....
```

To make the control work, the register and the program must be linked in System Manager. If the PLC program is attached in System Manager the following signals are available:



Analog the registers of the terminal bus are shown in System Manager :



Link signals and variables :

k_bus_err_code with ErrorCode

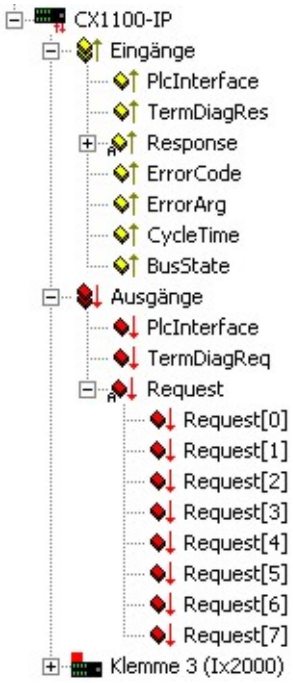
k_bus_err_arg with ErrorArg

k_bus_state with BusState

and

k_bus_request with Request[0]

The same handling for IP-Link signals:

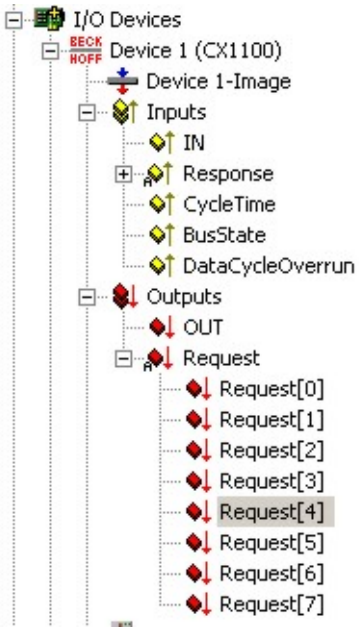


ip_bus_err_code	with	ErrorCode
ip_bus_err_arg	with	ErrorArg
ip_bus_state	with	BusState
ip_bus_request	with	Request[0]

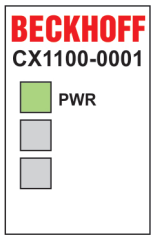
If all signals are linked the programmer can load configuration and PLC program onto the system.

Firmware > B7

With a new firmware release B7 it is easier to access the diagnosis values. The solution described above clears the error code if the reason for the error is no longer present. With the firmware > B7 its possible to get the error codes directly in the case of the error. To access the error codes the Bit 4 in GCB must be set to 1. So for diagnosis its a good idea to set the bit in the initialization of error routine or PLC program. The bit must be linked to the bit 4 in GCB:


I/O Devices
Device 1 (CX1100)
Device 1-Image
Inputs
IN
Response
CycleTime
BusState
DataCycleOverrun
Outputs
OUT
Request
Request[0]
Request[1]
Request[2]
Request[3]
Request[4]
Request[5]
Request[6]
Request[7]

5.2 CX1100-0001 power supply LEDs

Display	LED	Meaning
	Power	The LED lights up green when the power supply is correct, but red if there is a short circuit.

5.3 CX1100-0002 power supply LEDs

After switching on, the power supply immediately checks the connected Bus Terminal configuration. Error-free start-up is signalled by the red "I/O ERR" LED being extinguished. If the "I/O ERR" LED blinks, an error in the area of the terminals is indicated. The error code can be determined from the frequency and number of blinks. This permits rapid rectification of the error.

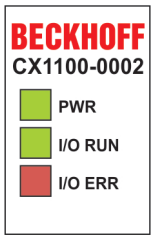
Display	LED	Meaning
	Power	Power supply The LED lights up green when the power supply is correct, but red if there is a short circuit.
	I/O Run	K-Bus diagnostics The green LED lights up in order to indicate fault-free operation. "Fault-free" means that the communication with the fieldbus system is also running.
	I/O Error	K-Bus diagnostics The red LED flashes to indicate an error. The red LED blinks with two different frequencies.

Table 2: The I/O error LED blink code

Fast blinking	Start of the error code
First slow sequence	Error code
Second slow sequence	Error code argument

LEDs for K-Bus diagnosis

Error code	Error code argument	Description	Remedy
Persistent, continuous blinking		EMC problems	- Check power supply for overvoltage or undervoltage peaks - Implement EMC measures - If a K-Bus error is present, it can be localised by a restart of the power supply (by switching it off and then on again)

Error code	Error code argument	Description	Remedy
1 pulse	0	EEPROM checksum error	Revert to the manufacturer's setting
	1	Code buffer overflow	Insert fewer Bus Terminals. The programmed configuration has too many entries in the table
	2	Unknown data type	Software update required for the power supply
2 pulses	0	Programmed configuration has an incorrect table entry	Check programmed configuration for correctness
	n (n > 0)	Table comparison (Bus Terminal n)	Incorrect table entry
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 until the defective Bus Terminal is located.
4 pulses	0	K-Bus data error, break behind the power supply	Check whether the n+1 Bus Terminal is correctly connected; replace if necessary.
	n	Break behind Bus Terminal n	Check whether the Bus End Terminal 9010 is connected.
5 pulses	n	K-Bus error in register communication with Bus Terminal n	Exchange the nth bus terminal
9 pulses	0	Checksum error in Flash program	Revert to the manufacturer's setting
	n (n>0)	Bus Terminal n is not consistent with the configuration that existed when the boot project was created	Revert to the manufacturer's setting which will clear the boot project.
14 pulses	n	nth Bus Terminal has the wrong format	Start the power supply again, and if the error occurs again then exchange the Bus Terminal.
15 pulses	n	Number of Bus Terminals is no longer correct	Start the power supply up again.
16 pulses	n	Length of the K-Bus data is no longer correct	Start the power supply up again.

Error code argument

The number of pulses indicates the position of the last Bus Terminal before the fault. Passive Bus Terminals, such as a power feed terminal, are not included in the count.

In the case of some errors, rectification does not cause the power supply to leave the blink sequence. The power supply can only be restarted by switching its supply voltage off and on again.

Note:

The supply voltage of the power supply unit, which is necessary to supply power to the CX1000 system, must not be interrupted in the middle of operation. Switching off the supply voltage to the power supply unit refers here to the power supply on the power contacts.

5.4 CX1100-0012 power supply LEDs

After switching on, the power supply immediately checks the connected Bus Terminal configuration. Error-free start-up is signaled by the red "I/O ERR" LED being extinguished. If the "I/O ERR" LED blinks, an error in the area of the terminals is indicated. The error code can be determined from the frequency and number of blinks. This permits rapid rectification of the error.

Display	LED	Meaning
	Power	Power supply The LED lights up green when the power supply is correct, but red if there is a short circuit.
	I/O Run	K-Bus diagnostics The green LED lights up in order to indicate fault-free operation. "Fault-free" means that the communication with the fieldbus system is also running.
	I/O Error	K-Bus diagnostics The red LED flashes to indicate an error. The red LED blinks with two different frequencies.

Table 3: The I/O error LED blink code

Fast blinking	Start of the error code
First slow sequence	Error code
Second slow sequence	Error code argument

LEDs for K-Bus diagnosis

Error code	Error code argument	Description	Remedy
Persistent, continuous blinking		EMC problems	- Check power supply for overvoltage or undervoltage peaks - Implement EMC measures - If a K-Bus error is present, it can be localised by a restart of the power supply (by switching it off and then on again)
1 pulse	0	EEPROM checksum error	Revert to the manufacturer's setting
	1	Code buffer overflow	Insert fewer Bus Terminals. The programmed configuration has too many entries in the table
	2	Unknown data type	Software update required for the power supply
2 pulses	0	Programmed configuration has an incorrect table entry	Check programmed configuration for correctness
	n (n > 0)	Table comparison (Bus Terminal n)	Incorrect table entry

Error code	Error code argument	Description	Remedy
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 until the defective Bus Terminal is located.
4 pulses	0	K-Bus data error, break behind the power supply	Check whether the n+1 Bus Terminal is correctly connected; replace if necessary.
	n	Break behind Bus Terminal n	Check whether the Bus End Terminal 9010 is connected.
5 pulses	n	K-Bus error in register communication with Bus Terminal n	Exchange the nth bus terminal
9 pulses	0	Checksum error in Flash program	Revert to the manufacturer’s setting
	n (n>0)	Bus Terminal n is not consistent with the configuration that existed when the boot project was created	Revert to the manufacturer's setting which will clear the boot project.
14 pulses	n	nth Bus Terminal has the wrong format	Start the power supply again, and if the error occurs again then exchange the Bus Terminal.
15 pulses	n	Number of Bus Terminals is no longer correct	Start the power supply up again.
16 pulses	n	Length of the K-Bus data is no longer correct	Start the power supply up again.

Error code argument

The number of pulses indicates the position of the last Bus Terminal before the fault. Passive Bus Terminals, such as a power feed terminal, are not included in the count.

In the case of some errors, rectification does not cause the power supply to leave the blink sequence. The power supply can only be restarted by switching its supply voltage off and on again.

Note:

The supply voltage of the power supply unit, which is necessary to supply power to the CX1000 system, must not be interrupted in the middle of operation. Switching off the supply voltage to the power supply unit refers here to the power supply on the power contacts.

5.5 CX1100-0003 power supply LEDs

After switching on, the power supply immediately checks the connected Bus Terminal configuration. Error-free start-up is signalled by the red "I/O ERR” LED being extinguished. If the ”I/O ERR" LED blinks, an error in the area of the terminals is indicated. The error code can be determined from the frequency and number of blinks. This permits rapid rectification of the error. Though the power supply supports two bus systems both bus errors are reported by the "I/O-Err" LED. An error ob K-Bus is reported by rapid blinking. One long flash (app. 2 sec.) reports errors on IP-Link-bus.

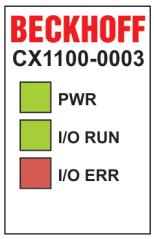
Display	LED	Meaning
	Power	Power supply The LED lights up green when the power supply is correct, but red if there is a short circuit.
	I/O Run	K-Bus diagnostics / IP-Link diagnostics The green LED lights up in order to indicate fault-free operation. "Fault-free" means that the communication with the fieldbus system is also running.
	I/O Error	K-Bus diagnostics / IP-Link diagnostics The red LED flashes to indicate an error. The red LED blinks with two different frequencies.

Table 4: The I/O error LED blink code

Fast blinking	Start of the error code
First slow sequence	Error code
Second slow sequence	Error code argument

LEDs for K-Bus diagnosis

Error code	Error code argument	Description	Remedy
Persistent, continuous blinking		EMC problems	- Check power supply for overvoltage or undervoltage peaks - Implement EMC measures - If a K-Bus error is present, it can be localised by a restart of the power supply (by switching it off and then on again)
1 pulse	0	EEPROM checksum error	Revert to the manufacturer's setting
	1	Code buffer overflow	Insert fewer Bus Terminals. The programmed configuration has too many entries in the table
	2	Unknown data type	Software update required for the power supply
2 pulses	0	Programmed configuration has an incorrect table entry	Check programmed configuration for correctness
	n (n > 0)	Table comparison (Bus Terminal n)	Incorrect table entry
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 until the defective Bus Terminal is located.

Error code	Error code argument	Description	Remedy
4 pulses	0	K-Bus data error, break behind the power supply	Check whether the n+1 Bus Terminal is correctly connected; replace if necessary.
	n	Break behind Bus Terminal n	Check whether the Bus End Terminal 9010 is connected.
5 pulses	n	K-Bus error in register communication with Bus Terminal n	Exchange the nth bus terminal
9 pulses	0	Checksum error in Flash program	Revert to the manufacturer's setting
	n (n>0)	Bus Terminal n is not consistent with the configuration that existed when the boot project was created	Revert to the manufacturer's setting which will clear the boot project.
14 pulses	n	nth Bus Terminal has the wrong format	Start the power supply again, and if the error occurs again then exchange the Bus Terminal.
15 pulses	n	Number of Bus Terminals is no longer correct	Start the power supply up again.
16 pulses	n	Length of the K-Bus data is no longer correct	Start the power supply up again.

Error code argument

The number of pulses indicates the position of the last Bus Terminal before the fault. Passive Bus Terminals, such as a power feed terminal, are not included in the count.

In the case of some errors, rectification does not cause the power supply to leave the blink sequence. The power supply can only be restarted by switching its supply voltage off and on again.

Note:

The supply voltage of the power supply unit, which is necessary to supply power to the CX1000 system, must not be interrupted in the middle of operation. Switching off the supply voltage to the power supply unit refers here to the power supply on the power contacts.

LEDs for IP-Link-Bus-Diagnosis

After a long flash (app.. 2 sec.) an IP-Link-Bus error has occurred. The following tables describe the error codes and help to find the reason for the error. IP-Link errors most often turn out to be a result of inappropriate use of the optical fiber.

I/O Err			Description	Remedy
off			No data exchange	Module in synchronous mode or - activate Profibus cyclic data
1	0		EEPROM checksum error	Set manufacturer's setting with the KS2000 software
2			Reserved	-
3			Break location has been recognized	interruption before the master's receiver
3	n		Break location has been recognized	n-th module before the master's receiver
3	n	m	Break location has been recognized	(n*10)+m-th module before the master's receiver

I/O Err		Description	Remedy
4	n	Too many faulty telegrams have been detected (more than 25%)	The optical fiber wiring in front of the nth extension module should be checked
5	n	Register access to complex modules has failed	Check the nth module
11	n	Complex module working incorrectly	Exchange the nth module
12	n	More than 120 modules in the ring	Connect fewer modules
13	n	nth module unknown	Firmware update required
off		Module is exchanging data	no error

Note

If an error occurs on both terminal busses (K-Bus and IP-Link-Bus) the error on K-Bus is reported at first. The IP-Link-Bus error is reported as second. Both error codes are introduced by their typical blink signal.

5.6 CX1100-0013 power supply LEDs

After switching on, the power supply immediately checks the connected Bus Terminal configuration. Error-free start-up is signaled by the red "I/O ERR" LED being extinguished. If the "I/O ERR" LED blinks, an error in the area of the terminals is indicated. The error code can be determined from the frequency and number of blinks. This permits rapid rectification of the error. Though the power supply supports two bus systems both bus errors are reported by the "I/O-Err" LED. An error on K-Bus is reported by rapid blinking. One long flash (app. 2 sec.) reports errors on IP-Link-bus.

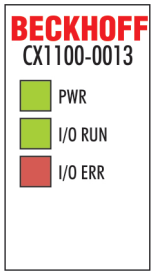
Display	LED	Meaning
	Power	Power supply The LED lights up green when the power supply is correct, but red if there is a short circuit.
	I/O Run	K-Bus diagnostics / IP-Link diagnostics The green LED lights up in order to indicate fault-free operation. "Fault-free" means that the communication with the fieldbus system is also running.
	I/O Error	K-Bus diagnostics / IP-Link diagnostics The red LED flashes to indicate an error. The red LED blinks with two different frequencies.

Table 5: The I/O error LED blink code

Fast blinking	Start of the error code
First slow sequence	Error code
Second slow sequence	Error code argument

LEDs for K-Bus diagnosis

Error code	Error code argument	Description	Remedy
Persistent, continuous blinking		EMC problems	- Check power supply for overvoltage or undervoltage peaks - Implement EMC measures - If a K-Bus error is present, it can be localised by a restart of the power supply (by switching it off and then on again)
1 pulse	0	EEPROM checksum error	Revert to the manufacturer's setting
	1	Code buffer overflow	Insert fewer Bus Terminals. The programmed configuration has too many entries in the table
	2	Unknown data type	Software update required for the power supply
2 pulses	0	Programmed configuration has an incorrect table entry	Check programmed configuration for correctness
	n (n > 0)	Table comparison (Bus Terminal n)	Incorrect table entry
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 until the defective Bus Terminal is located.
4 pulses	0	K-Bus data error, break behind the power supply	Check whether the n+1 Bus Terminal is correctly connected; replace if necessary.
	n	Break behind Bus Terminal n	Check whether the Bus End Terminal 9010 is connected.
5 pulses	n	K-Bus error in register communication with Bus Terminal n	Exchange the nth bus terminal
9 pulses	0	Checksum error in Flash program	Revert to the manufacturer's setting
	n (n>0)	Bus Terminal n is not consistent with the configuration that existed when the boot project was created	Revert to the manufacturer's setting which will clear the boot project.
14 pulses	n	nth Bus Terminal has the wrong format	Start the power supply again, and if the error occurs again then exchange the Bus Terminal.
15 pulses	n	Number of Bus Terminals is no longer correct	Start the power supply up again.
16 pulses	n	Length of the K-Bus data is no longer correct	Start the power supply up again.

Error code argument

The number of pulses indicates the position of the last Bus Terminal before the fault. Passive Bus Terminals, such as a power feed terminal, are not included in the count.

In the case of some errors, rectification does not cause the power supply to leave the blink sequence. The power supply can only be restarted by switching its supply voltage off and on again.

Note:

The supply voltage of the power supply unit, which is necessary to supply power to the CX1000 system, must not be interrupted in the middle of operation. Switching off the supply voltage to the power supply unit refers here to the power supply on the power contacts.

LEDs for IP-Link-Bus-Diagnosis

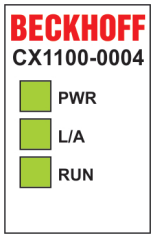
After a long flash (app.. 2 sec.) an IP-Link-Bus error has occurred. The following tables describe the error codes and help to find the reason for the error. IP-Link errors most often turn out to be a result of inappropriate use of the optical fiber.

I/O Err			Description	Remedy
off			No data exchange	Module in synchronous mode or - activate Profibus cyclic data
1	0		EEPROM checksum error	Set manufacturer's setting with the KS2000 software
2			Reserved	-
3			Break location has been recognized	interruption before the master's receiver
3	n		Break location has been recognized	n-th module before the master's receiver
3	n	m	Break location has been recognized	(n*10)+m-th module before the master's receiver
4	n		Too many faulty telegrams have been detected (more than 25%)	The optical fiber wiring in front of the nth extension module should be checked
5	n		Register access to complex modules has failed	Check the nth module
11	n		Complex module working incorrectly	Exchange the nth module
12	n		More than 120 modules in the ring	Connect fewer modules
13	n		nth module unknown	Firmware update required
off			Module is exchanging data	no error

Note

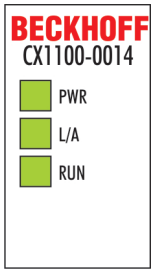
If an error occurs on both terminal busses (K-Bus and IP-Link-Bus) the error on K-Bus is reported at first. The IP-Link-Bus error is reported as second. Both error codes are introduced by their typical blink signal.

5.7 CX1100-0004 power supply LEDs

Display	LED		Meaning
	PWR		power supply The LED lights up green when the power supply is correct, but red if there is a short circuit.
	L/A	off	E-Bus is not connected
		on	E-Bus is connected / no data traffic on E-bus
		blink	E-Bus is connected / data traffic on E-bus
	RUN		Indicates the state of the EtherCAT bus:
		off	INIT
		blink	PRE-OPERATIONAL (frequency: 200 ms on / 200 ms off)
		single flash	SAVE-OPERATIONAL (frequency: 200 ms on / 1000ms off)
		on	OPERATIONAL
		flickering	BOOTSTRAP (frequency: 50 ms on / 50 ms off)
		double flash	reserved for future use (frequency: 200 ms on / 200 ms off / 200 ms on / 1000 ms off)
		triple flash	reserved for future use (frequency: 200 ms on / 200 ms off / 200 ms on / 200 ms off / 200 ms on / 1000 ms off)
		quadruple flash	reserved for future use (frequency: 200 ms on / 200 ms off / 200 ms on / 200 ms off / 200 ms on / 200 ms off / 200 ms on / 1000 ms off)

The functions for L/A and RUN LED are available in hardware revision > 2.0. The LEDs have no function in older revisions.

5.8 CX1100-0014 power supply LEDs

Display	LED		Meaning
	PWR		power supply The LED lights up green when the power supply is correct, but red if there is a short circuit.
	L/A	off	E-Bus is not connected
		on	E-Bus is connected / no data traffic on E-bus
		blink	E-Bus is connected / data traffic on E-bus
	RUN		Indicates the state of the EtherCAT bus:
		off	INIT
		blink	PRE-OPERATIONAL (frequency: 200 ms on / 200 ms off)
		single flash	SAVE-OPERATIONAL (frequency: 200 ms on / 1000ms off)
		on	OPERATIONAL
		flickering	BOOTSTRAP (frequency: 50 ms on / 50 ms off)
		double flash	reserved for future use (frequency: 200 ms on / 200 ms off / 200 ms on / 1000 ms off)
		triple flash	reserved for future use (frequency: 200 ms on / 200 ms off / 200 ms on / 200 ms off / 200 ms on / 1000 ms off)
		quadruple flash	reserved for future use (frequency: 200 ms on / 200 ms off / 200 ms on / 200 ms off / 200 ms on / 200 ms off / 200 ms on / 1000 ms off)

The functions for L/A and RUN LED are available in hardware revision > 2.0. The LEDs have no function in older revisions.

6 Decommissioning

6.1 Removal and disposal

A CX10x0 hardware configuration is dismantled in 2 stages:

0. Switching off and disconnecting the power supply

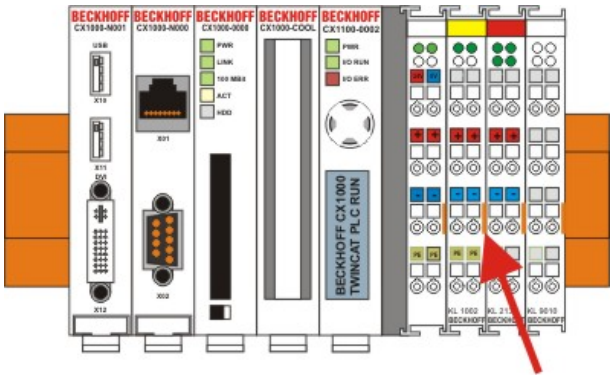
Before a CX10x0 system can be dismantled, the system should be switched off, and the power supply should be disconnected.

1. Removing from the top-hat rail:

Before the individual CX10x0 modules are disconnected, the whole CX1020 hardware block should be removed from the top-hat rail. Proceed as follows:

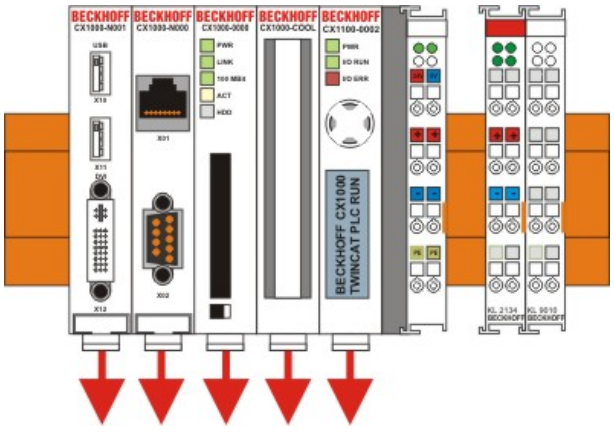
1.1. Release and remove the first Terminal next to the power supply unit on the top-hat rail.

First remove any wiring from power supply unit *and* then from the first terminal on the top-hat rail next to the power supply unit. If the wiring is to be reused for another system, it is advisable to make a note of the connections. Then pull the orange terminal release (see arrow) to release the terminal and pull it out.



1.2. Releasing the CX10x0 system

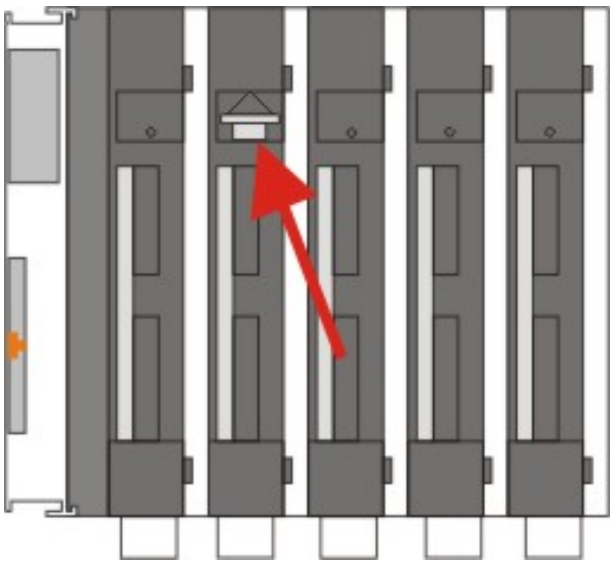
In order to release the CX10x0 block, pull the white straps at the bottom of the module in the direction of the arrows. They will lock in the extended position. After pulling the terminal release of the power supply unit, the block can be removed *carefully* from the top-hat rail.



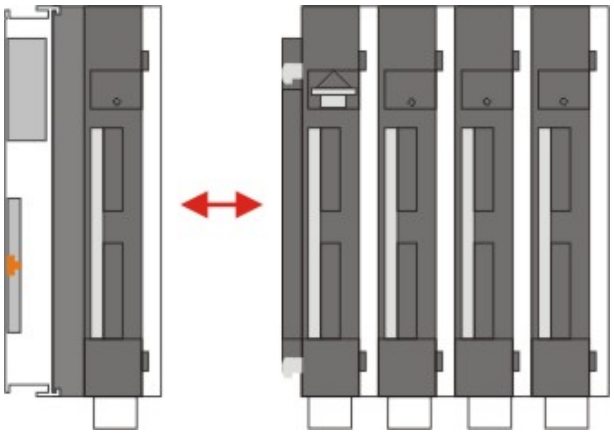
2. Separating the individual modules

2.1. Separating the power supply unit, the CX10x0 CPU and other components

Place the CX10x0 block onto a suitable support with the front facing down. Then insert a flat screwdriver with dimensions 1.0 x 5.5 x 150 mm into the locking mechanism, and then operating the slider by turning it about 90 degrees.



The locking mechanism on the rear affects an approx. 2-3 mm wide clearance of the module latching mechanism, pushing them apart. The plug connectors of the PC 104 interface can then be pulled apart carefully.



Only modules (CPU, fieldbus connections and UPS modules) that can be separated non-destructively feature a release device. Modules that cannot be separated only feature a marking point (with or without red paint seal). Applying force to these elements will destroy them.

Attention	Forcibly opening the module housing (e.g. removing the cover) will destroy the housing.

Disposal

The device must be fully dismantled in order to dispose of it.

Electronic parts must be disposed of in accordance with national electronics scrap regulations.

7 Appendix

7.1 ADS Return-Codes

Hex	Dec	Description
0x000	0	no error
0x001	1	Internal error
0x002	2	No Rtime
0x003	3	Allocation locked memory error
0x004	4	Insert mailbox error
0x005	5	Wrong receive HMSG
0x006	6	target port not found
0x007	7	target machine not found
0x008	8	Unknown command ID
0x009	9	Bad task ID
0x00A	10	No IO
0x00B	11	Unknown AMS command
0x00C	12	Win 32 error
0x00D	13	Port not connected
0x00E	14	Invalid AMS length
0x00F	15	Invalid AMS Net ID
0x010	16	Low Installation level
0x011	17	No debug available
0x012	18	Port disabled
0x013	19	Port already connected
0x014	20	AMS Sync Win32 error
0x015	21	AMS Sync Timeout
0x016	22	AMS Sync AMS error
0x017	23	AMS Sync no index map
0x018	24	Invalid AMS port
0x019	25	No memory
0x01A	26	TCP send error
0x01B	27	Host unreachable
0x500	1280	Router: no locked memory
0x502	1282	Router: mailbox full
0x700	1792	error class <device error>
0x701	1793	Service is not supported by server
0x702	1794	invalid index group
0x703	1795	invalid index offset
0x704	1796	reading/writing not permitted
0x705	1797	parameter size not correct
0x706	1798	invalid parameter value(s)
0x707	1799	device is not in a ready state
0x708	1800	device is busy
0x709	1801	invalid context (must be in Windows)
0x70A	1802	out of memory
0x70B	1803	invalid parameter value(s)

Hex	Dec	Description
0x70C	1804	not found (files, ...)
0x70D	1805	syntax error in command or file
0x70E	1806	objects do not match
0x70F	1807	object already exists
0x710	1808	symbol not found
0x711	1809	symbol version invalid
0x712	1810	server is in invalid state
0x713	1811	AdsTransMode not supported
0x714	1812	Notification handle is invalid
0x715	1813	Notification client not registered
0x716	1814	no more notification handles
0x717	1815	size for watch too big
0x718	1816	device not initialized
0x719	1817	device has a timeout
0x71A	1818	query interface failed
0x71B	1819	wrong interface required
0x71C	1820	class ID is invalid
0x71D	1821	object ID is invalid
0x71E	1822	request is pending
0x71F	1823	request is aborted
0x720	1824	signal warning
0x721	1825	invalid array index
0x740	1856	Error class <client error>
0x741	1857	invalid parameter at service
0x742	1858	polling list is empty
0x743	1859	var connection already in use
0x744	1860	invoke ID in use
0x745	1861	timeout elapsed
0x746	1862	error in win32 subsystem
0x748	1864	ads-port not opened
0x750	1872	internal error in ads sync
0x751	1873	hash table overflow
0x752	1874	key not found in hash
0x753	1875	no more symbols in cache

7.2 Certifications

All products of the Embedded PC family are CE, UL and GOST-R certified. Since the product family is continuously developed further, we are unable to provide a full listing here. The current list of certified products can be found at www.beckhoff.com.

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.

7.3 Support and Service

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

Beckhoff's branch offices and representatives

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

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You will also find further documentation for Beckhoff components there.

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