



Beckhoff

PC Fieldbus card

CX Fieldbus module

DeviceNet:

FC520x / CX1500-x520

Version: 1.1
22.04.2004

BECKHOFF

Please note the following

<i>Target group</i>	This description is only intended for the use of trained specialists in control and automation engineering who are familiar with the applicable national standards.
<i>Safety requirements</i>	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.

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, and does not represent an assurance of characteristics in the sense of § 459, Para. 2 of the German Civil Code. 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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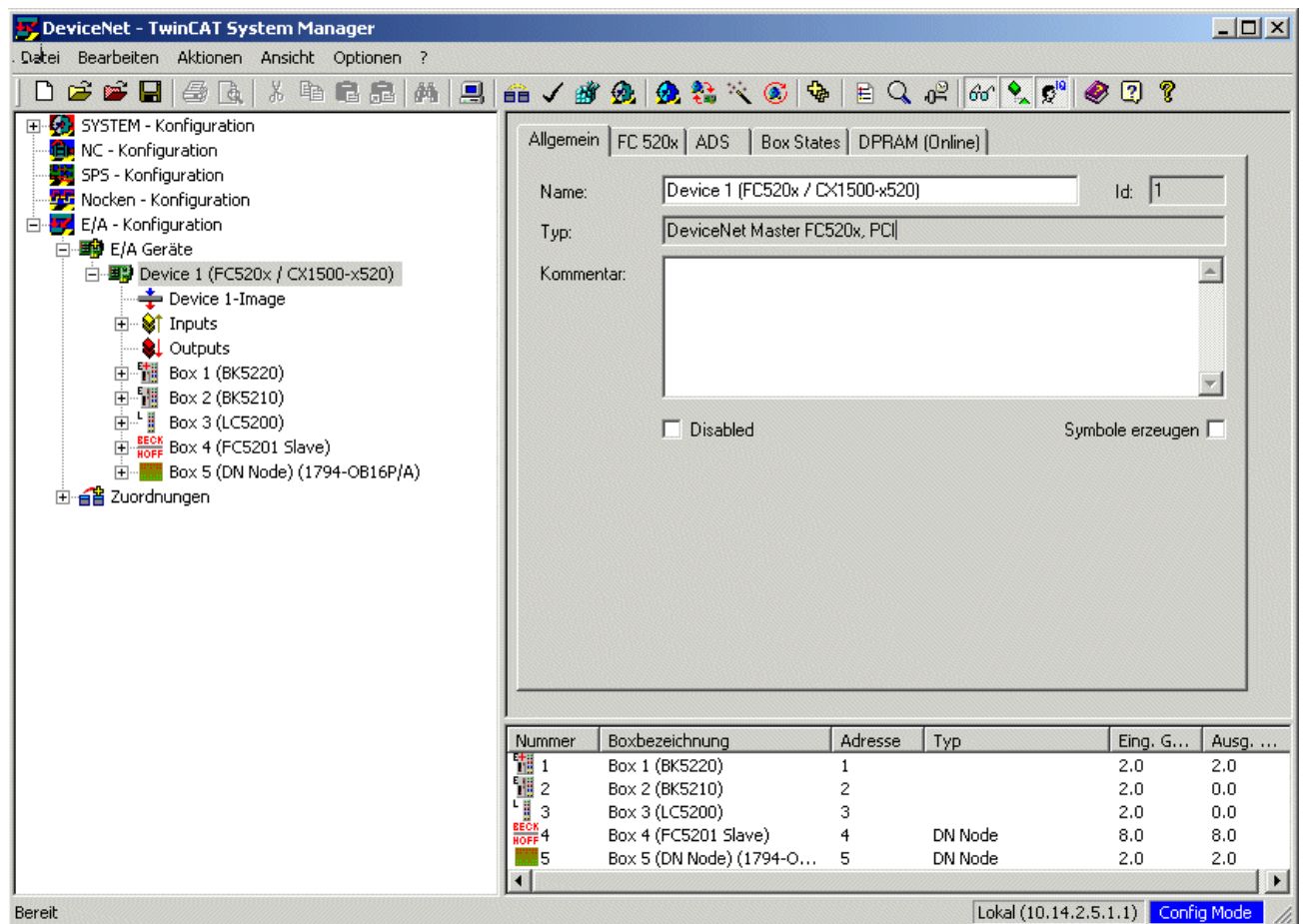
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1 Foreword

1.1 Introduction

The purpose of this document is to provide DeviceNet Specific Information needed to set up a DeviceNet Network with Beckhoff FC520x / CX1500-x520 DeviceNet Interface units. From DeviceNet point of view both units have the same functionalities. Therefore, this documentation serves for both.

Beside the Product Overview it shows the DeviceNet Configuration and Diagnostic Data of Beckhoff's TwinCAT System Manager using a Beckhoff DeviceNet Interface FC520x or CX1500-x520. It is intended for the usage of Master and Slave Interfaces and describes the meaning of the diagnostic inputs and explains the troubleshooting for the specific errors.



1.2 Safety Instructions

Safety Rules

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.

State at Delivery

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 Elektro BECKHOFF GmbH.

Personal Qualification

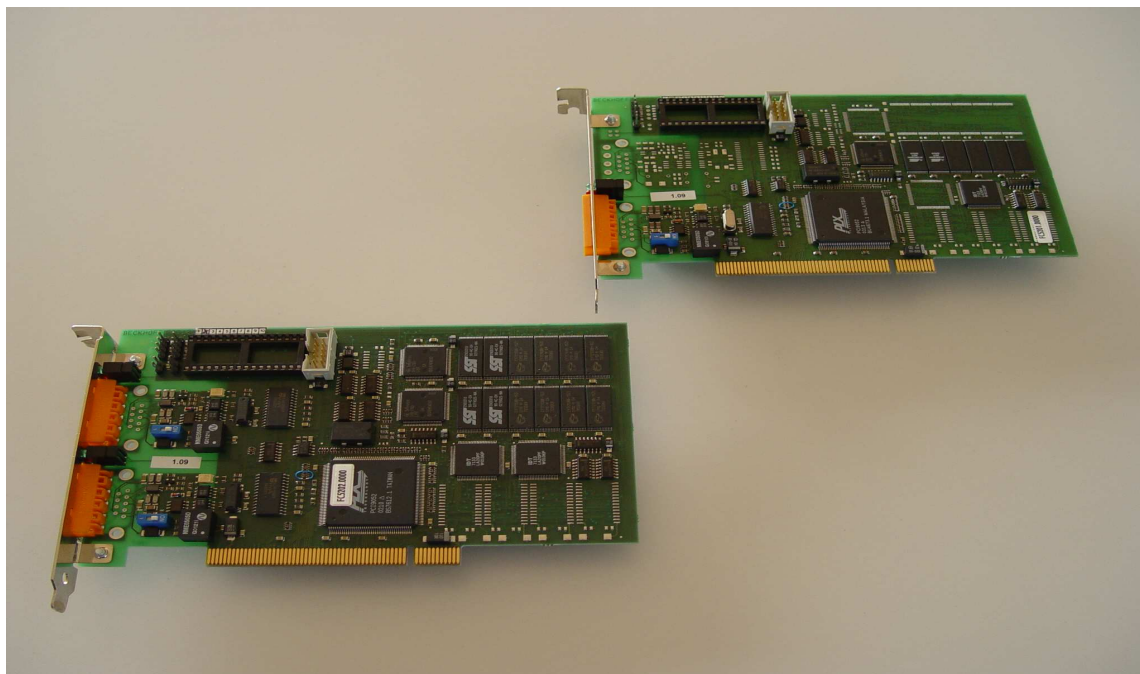
This description is only intended for the use of trained specialists in control and automation engineering who are familiar with the applicable national standards.

1.3 Version of the Documentation

Version	Changes
1.0	Preliminary Version, initial release
1.1	Added chapters: - Product Overview - Fitting and Wiring - Appendix

2 Product Overview

2.1 Beckhoff FC520x: Technical Documentation



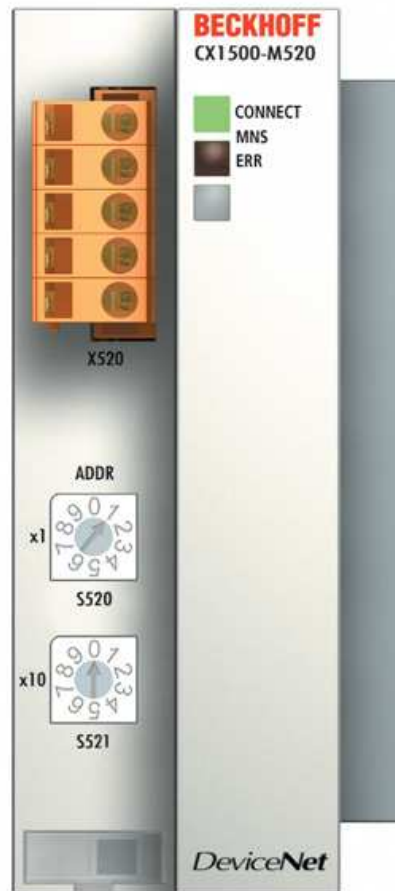
The FC5201 and FC5202 PC plug-in cards link the PC to a DeviceNet network. They can act as master or as slave modules. The PCI bus interface ensures both high transmission rates to the PC and fully automatic configuration of the cards in the PC hardware. The DeviceNet cards provide a powerful implementation of the protocol, offering many desirable features:

- One (FC5201) or two (FC5202) DeviceNet channels, each with its own processor, memory, etc.
- All DeviceNet I/O modes are supported: polling, change of state, cyclic, strobed
- Optionally two DeviceNet channels in parallel on one card are possible
- Powerful parameter and diagnostics interface
- The error management for each bus user is freely configurable
- It is possible to read the bus configuration and automatically assign the "eds" files
- Integrated bus loading display
- CAN interfaces are electrically isolated

Technical Data

Technical Data	FC5201	FC5202
Number of Fieldbus Channels	1	2
Transmission Rate	125, 250, 500 kbaud	
Interface to the PC	plug-and-play PCI interface 32 bit with 4 kbytes DPRAM per channel	
Bus Interface	open style connector 5-pin according to DeviceNet specification, galvanically isolated. Card comes with connector.	
Bus nodes	per channel: max. 63 slaves	
Process image	total max. 3 kbyte input and output data	
Communication	master and slave functionality	
Termination Resistor	Switchable	
Hardware diagnostics	2 LEDs per channel	
Dimensions	approx. 106 x 175 mm	
Operating temperature	0 °C ... 55 °C	

2.2 Beckhoff CX1500-x520: Technical Documentation



The CX1500-x520 links the CPU to a DeviceNet network. The CX1500-M520 can act as master, the CX1500-B520 as slave module. The DeviceNet interface provides a powerful implementation of the protocol, offering many desirable features:

- All DeviceNet I/O modes are supported: polling, change of state, cyclic, strobed
- Powerful parameter and diagnostics interface
- The error management for each bus user is freely configurable
- It is possible to read the bus configuration and automatically assign the "eds" files
- Integrated bus loading display

Technical Data

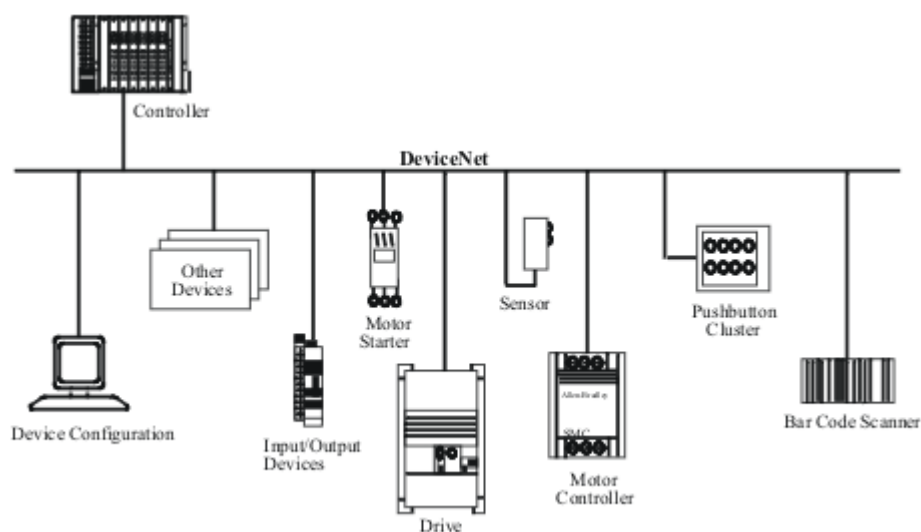
Technical Data	CX1500-M520	CX1500-B520
Number of Fieldbus Channels	1	1
Transmission Rate	125, 250, 500 kbaud	
Interface to the CPU	ISA plug and play, 2 kbyte DPRAM	
Bus connection	open style connector 5-pin according to DeviceNet specification	
Bus Nodes	max. 63 slaves	max. 63 slaves
Communication	master functionality	slave functionality
Dimensions (W x H x D)	38 mm x 100 mm x 91 mm	
Weight approx.	190 g	
Operating temperature	0 °C ... +55 °C	
Storage temperature	-25 °C ... +85 °C	
Relative humidity	95%, no condensation	
Vibration/shock resistance	conforms to IEC 68-2-6/IEC 68-2-29	
EMC resistance burst/ESD	conforms to EN 50082 (ESD, burst)/EN 50081	
Protection class	IP 20	

2.3 DeviceNet Introduction

DeviceNet is an open system based on CAN, developed by Bosch a few years ago. CAN was primarily intended for the transfer of data within automobiles, and millions on CAN Chips have since been installed. The disadvantage of using CAN in automation technology is that it does not define an application layer. It specifies only the physical layer and data security layer.

DeviceNet specifies a uniform application layer and this makes it possible to use the CAN protocol for industrial applications. ODVA (the open DeviceNet Vendor Association) is an independent association which supports Manufacturers and users of the DeviceNet system. ODVA ensures that all of the devices which conform to the specification can operate together in one system, regardless of their manufacturer.

Example of DeviceNet in use:

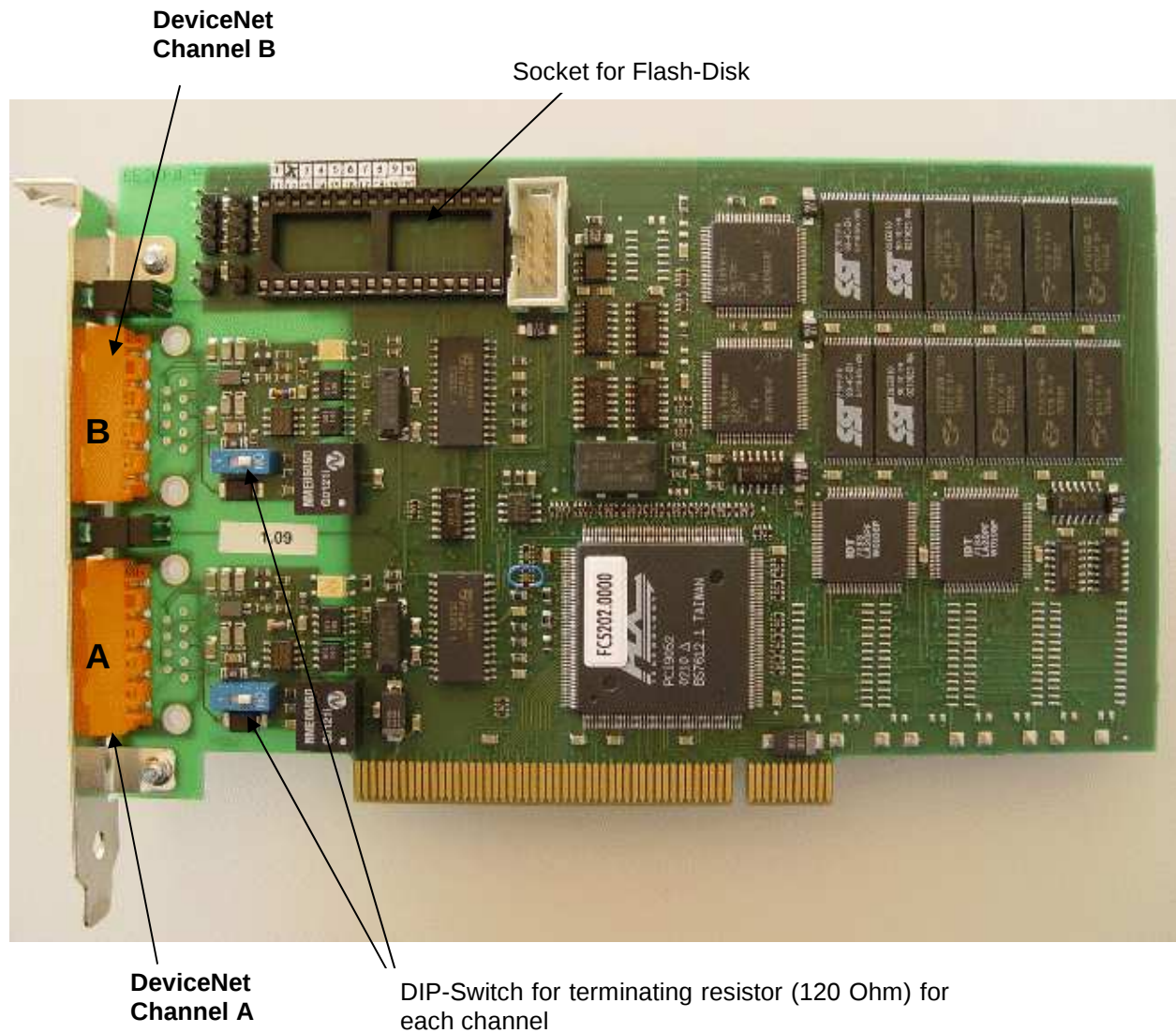


For more details see the DeviceNet Specification or look at www.odva.org, the official Internet address of the Open DeviceNet Vendor Association (ODVA).

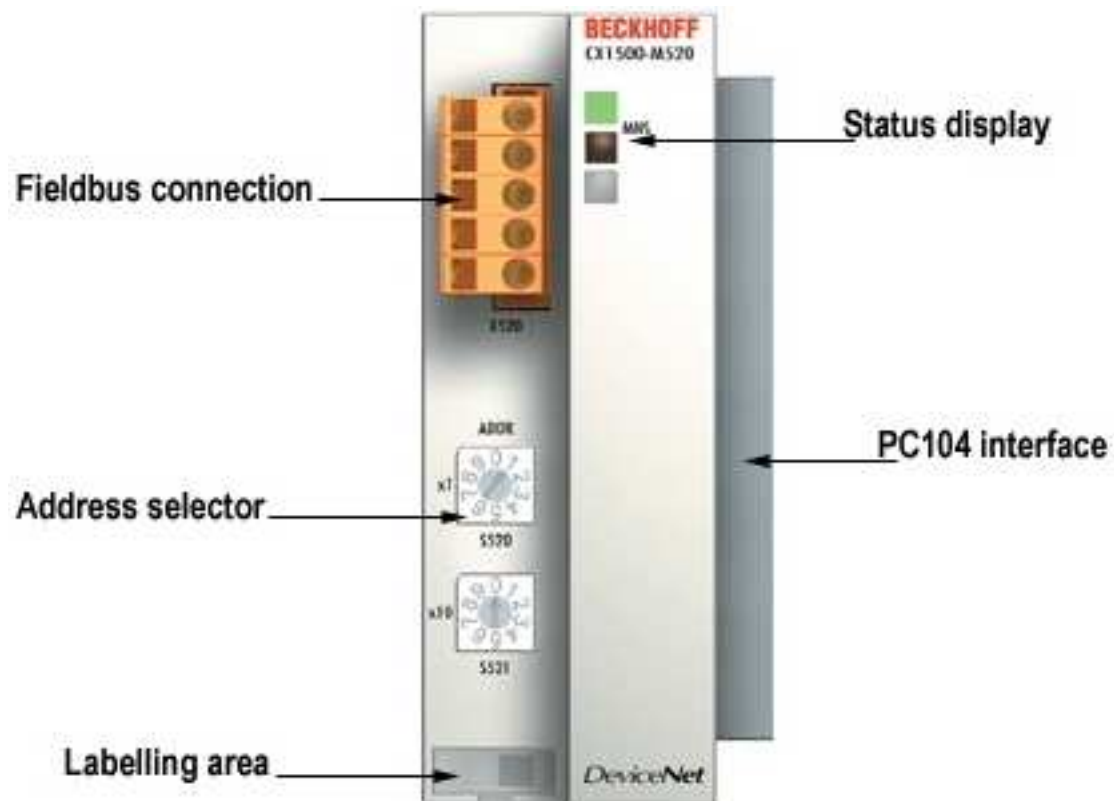
2.4 Hardware Description

2.4.1 FC520x - Overview

On the FC520x card there are DeviceNet / CAN termination resistors (120 Ohms). They can be activated with a DIP-Switch close to the DeviceNet Connector.



2.4.2 CX1500-x520 - Overview



Address Selector

With the CX1500-M520, the MAC-Id / Address is set within the TwinCAT System Manager
With the CX1500-B20, the MAC-Id / Address is set with the Address selector

2.5 DeviceNet Connector

To connect the DeviceNet Bus cable a 5-pin socket for each channel is mounted on the DeviceNet units.

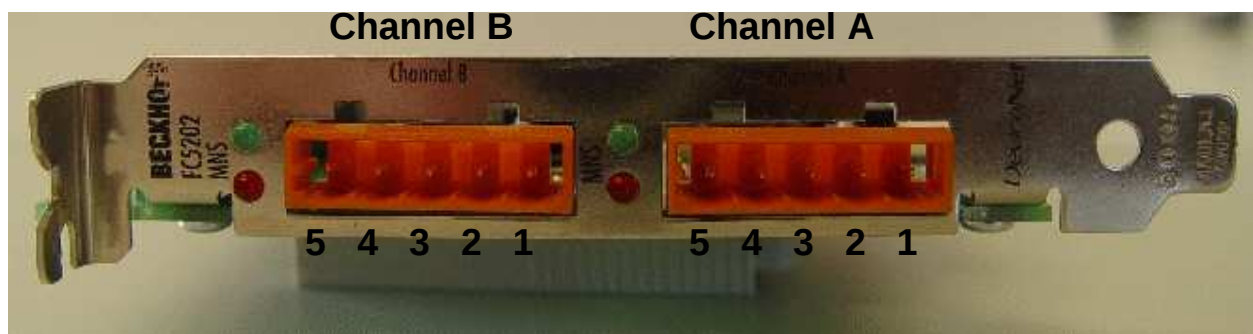
Note: It is mandatory to connect the DeviceNet Voltage to the Connector/System



DeviceNet Socket on FC520x / CX1500-x520

Pinout	Description
1	V+ (24 Volt)
2	CAN-High
3	Shield
4	CAN-Low
5	V-

FC520x:



3 Fitting and Wiring

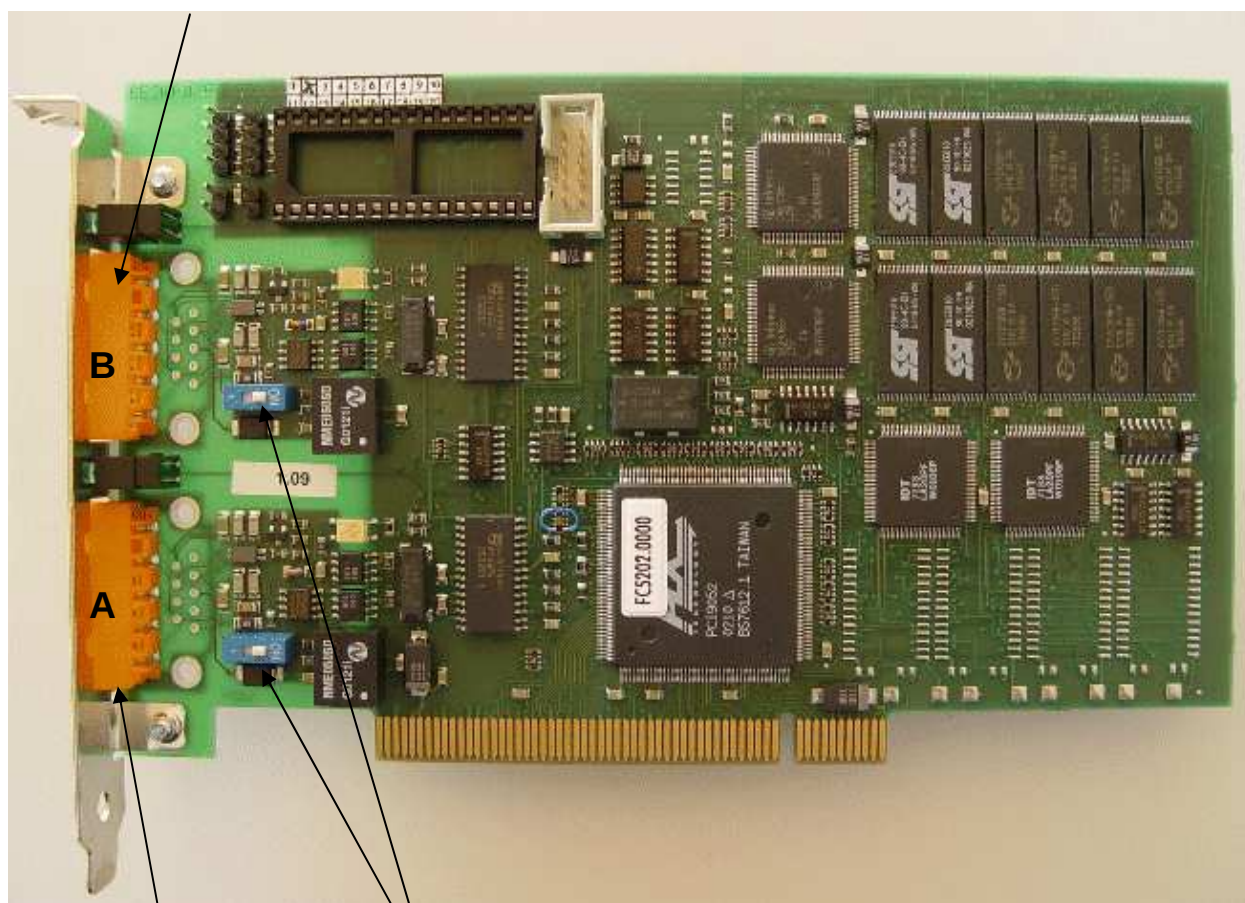
3.1 Installation

3.1.1 FC520x

Note: Fieldbus PCI cards may only be fitted by qualified personnel in accordance and the following points must be observed

- In order to protect the card from electrostatic discharge the user must be discharged before handling the card or the PC.
- Before opening the PC housing it must be switched off, and the mains plug must be removed.

**DeviceNet
Channel B**



**DeviceNet
Channel A**

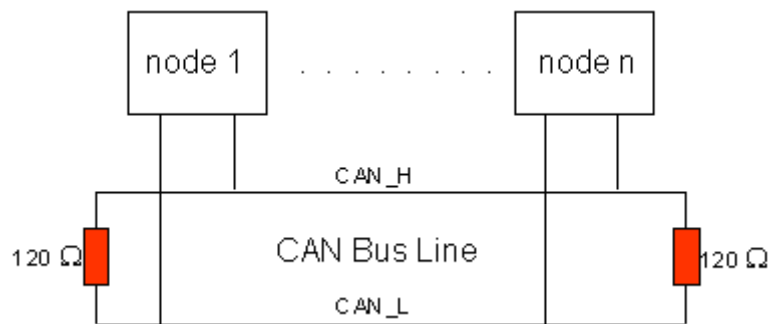
DIP-Switch for terminating resistor (120 Ohm) for each channel

It may be necessary before fitting to set the Dip-Switch in order to activate the internal CAN / DeviceNet bus terminating resistors. The card can be fitted into any free PCI slot. Ensure that the PCI bus connector is making good contact, and that the module is seated firmly. Fasten the module to the PC slot housing with the fixing screw.

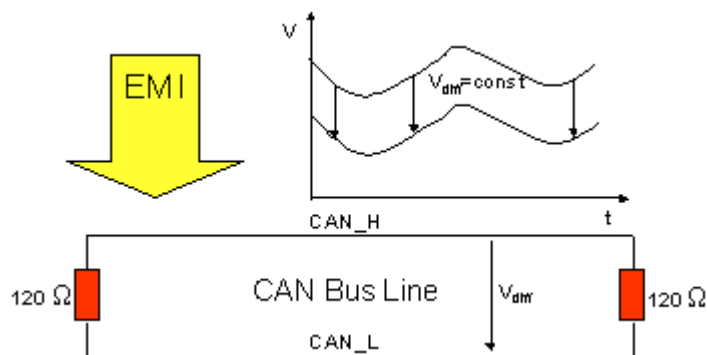
3.2 Wiring the Bus System

3.2.1 CAN / DeviceNet topology

CAN / DeviceNet is a 2-wire bus system, to which all participating devices are connected in parallel (i.e. using short drop lines). The bus must be terminated at each end with a 120 (or 121) Ohm terminating resistor to prevent reflections. This is also necessary even if the cable lengths are very short!



Since the CAN signals are represented on the bus as the difference between the two levels, the CAN leads are not very sensitive to incoming interference (EMI): Both leads are affected, so the interference has very little effect on the difference.



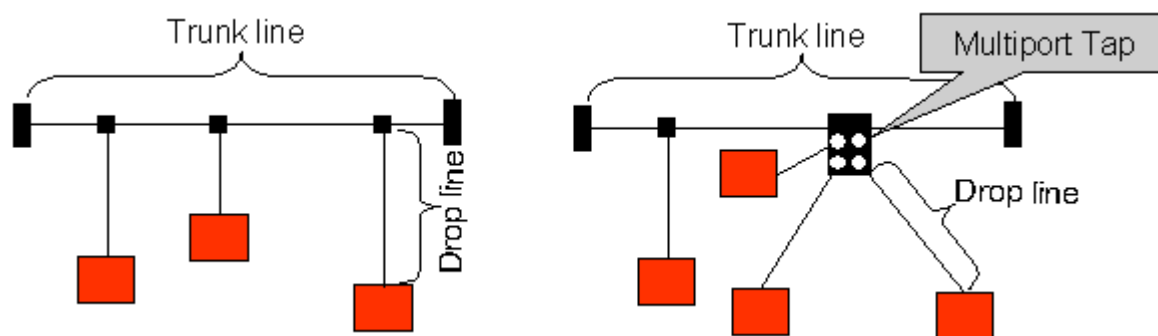
3.2.2 Bus Length

The maximum length of a CAN bus is primarily limited by the signal transit time. The multi-master bus access procedure (arbitration) requires signals to reach all the nodes at effectively the same time (before the sampling within a bit period). Since the signal transit times in the CAN connecting equipment (transceivers, opto-couplers, CAN controllers) are almost constant, the line length must be chosen in accordance with the baud rate:

For the DeviceNet use of the CAN Bus following Baud Rates and Bus Lengths are specified:

BaudRate	Bus Length
500 kbit/s	< 100 m
250 kbit/s	< 250 m
125 kbit/s	< 500 m

3.2.3 Drop-Lines



Drop lines must always be avoided as far as possible, since they inevitably cause reflections. The reflections caused by drop lines are not however usually critical, provided they have decayed fully before the sampling time. In the case of the bit timing settings selected in the bus couplers it can be assumed that this is the case, provided the following drop line lengths are not exceeded (according to DeviceNet Specification):

BaudRate	Drop line length	Total length of all drop lines
500 kbit/s	< 6 m	< 39 m
250 kbit/s	< 6 m	< 78 m
125 kbit/s	< 6 m	< 156 m

Drop lines must not have terminating resistors.

Star Hub (Multiport Tap)

Shorter drop line lengths must be maintained with passive distributors ("multiport taps"), such as the Beckhoff ZS5052-4500 Distributor Box. The following table indicates the maximum drop line lengths and the maximum length of the trunk line (without the drop lines):

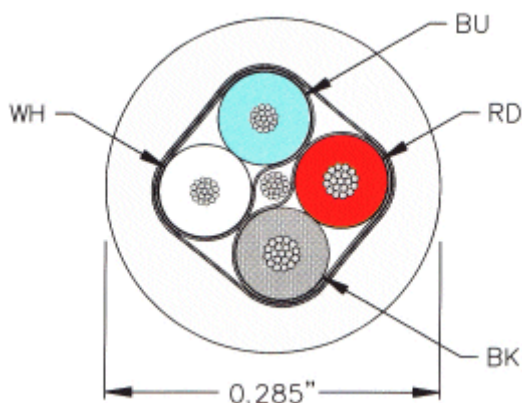
Note: These values are recommended by Beckhoff

BaudRate	Drop line length with multi-port topology	Trunk line length (without drop lines)
500 kbit/s	< 1,2 m	< 66 m
250 kbit/s	< 2,4 m	< 120 m
125 kbit/s	< 4.8 m	< 310 m

3.2.4 DeviceNet Cable – ZB5200

The ZB5200 cable material corresponds to the DeviceNet specification. The ready-made ZK1052-xxxx-xxxx bus cables for the Fieldbus Box modules are made from this cable material. It has the following specification:

- 2 x 2 x 0.34 mm² (AWG 22) twisted pairs
- double screened braided screen with filler strand
- characteristic impedance (1 MHz): 126 Ohm
- conductor resistance 54 Ohm/km
- sheath: grey PVC, external diameter 7.3 mm
- printed with "InterlinkBT DeviceNet Type 572" as well as UL and CSA ratings
- stranded wire colours correspond to the DeviceNet specification
- UL recognised AWM Type 2476 rating
- CSA AWM I/II A/B 80°C 300V FT1
- corresponds to the DeviceNet "Thin Cable" specification



Cable colours

Description	DeviceNet-cable colour
V+ (24 Volt)	Red
CAN-High	White
Shield	Filler strand
CAN-Low	Blue
V-	Black

4 Parameterisation and Commissioning

4.1 Configuration: TwinCAT System Manager

The TwinCAT System Manager Tool is used to configure the FC520x DeviceNet PCI card and the CX1500-x520 Fieldbus Modules. The System Manager provides a representation of the number of programs of the TwinCat PLC systems, the configuration of the axis control and of the connected I/O channels as a structure, and organises the mapping of the data traffic.



For applications without TwinCAT PLC or NC, the TwinCAT System Manager Tool configures the programming interfaces for a wide range of application programs:

- ActiveX control (ADS-OCX) for e.g. Visual Basic, Visual C++, Delphi, etc.
- DLL interface (ADS-DLL) for e.g. Visual C++ projects
- Script interface (ADS script DLL) for e.g. VBScript, JScript, etc.

4.1.1 System Manager – Features

- - Bit-wise association of server process images and I/O channels
- - Standard data formats such as arrays and structures
- - User defined data formats
- - Continuous variable linking
- - Drag and Drop
- - Import and export at all levels

4.1.2 Configuration by means of the TwinCAT System Manager

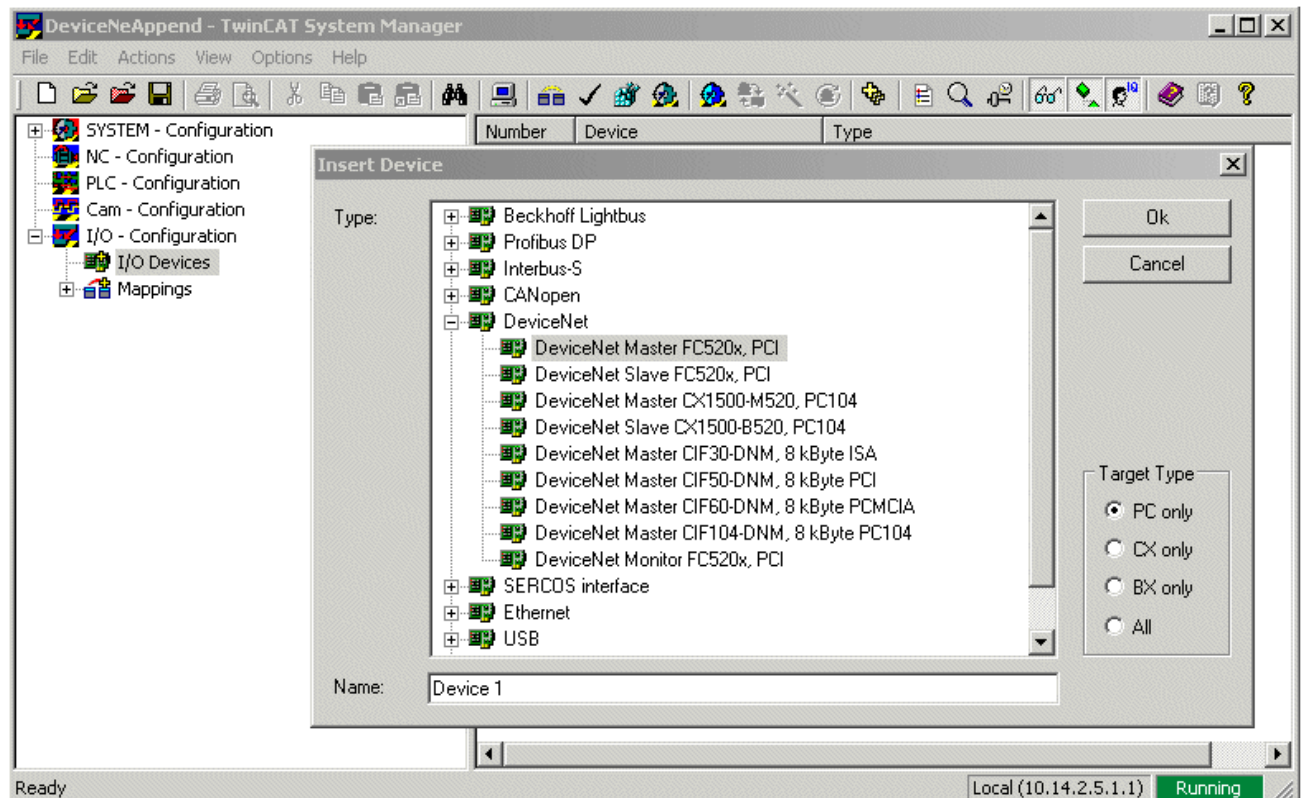
The procedure, and the configuration facilities in the System Manager are described within the next chapters.

4.2 DeviceNet Device

4.2.1 Append Device

Appending a Device can either be executed by running the “Scan-Devices” routine of the TwinCAT System Manager or by selecting manually the Device out of the list of possible DeviceNet Devices.

Appending the Device manually is done by e.g. selecting the “IO-Devices” and apply the right Mouse-Button:

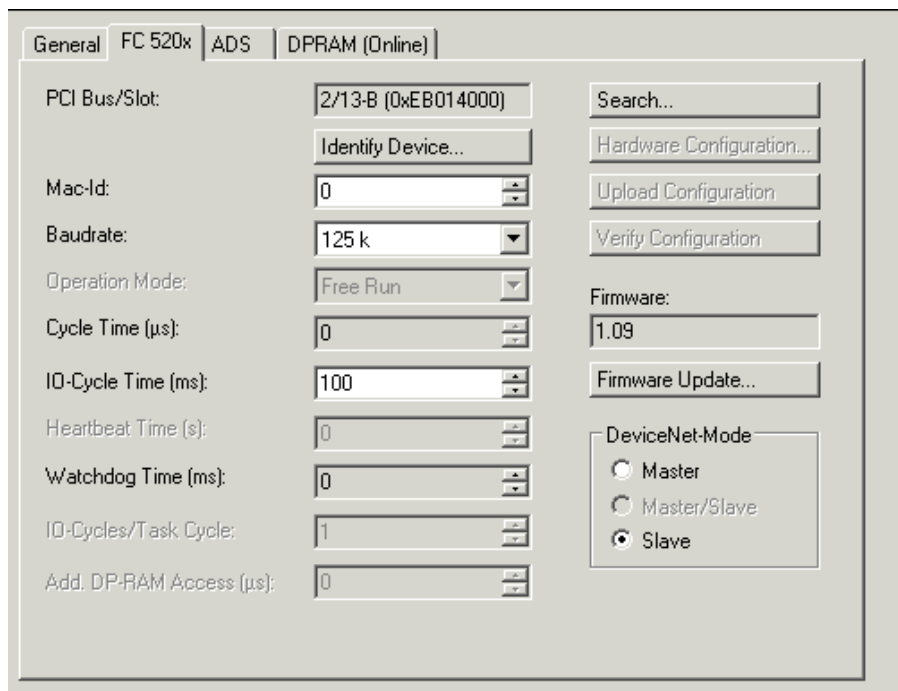


4.2.1.1 Append the FC520x as DeviceNet Slave

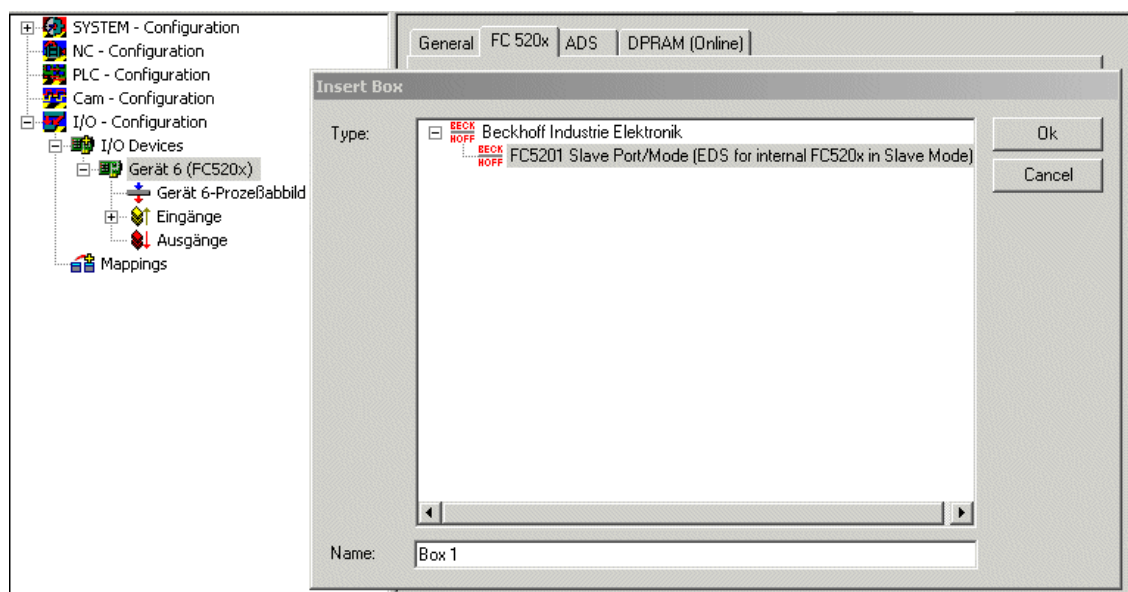
If the FC520x-Device is appended manually, all settings for the DeviceNet Slave are configured automatically.

If the FC520x-Device is appended with the “Scan-Devices” routine, TwinCAT should not search for new Boxes. The scan has to be stopped after detecting the FC520x and the following steps have to be done:

1. Switch the DeviceNet-Mode to “Slave”



2. Append Box for FC520x DeviceNet Slave Port



4.2.2 Configuration

4.2.2.1 FC520x / CX1500-x520

FC520x

PCI Slot/Irq: Shows in which logical PCI slot the card was detected and which IRQ is assigned to it. The IRQ is unused.

Search: Searches for all connected FC520x channels. Select those required. In the case of an FC5202 both channels A and B appear. These behave in logical terms like two FC5201 cards.

Upload Configuration: Scans the DeviceNet network and adds all found devices (boxes cannot be added). In the case of Beckhoff boxes, reads the configuration precisely. Searches external devices to find the corresponding EDS file.

Firmware: Shows the current firmware version of the FC520x.

Firmware Update: Update the FC520x card firmware version here.

MAC-ID: Each DeviceNet device requires a unique station number – MAC-ID (Medium Access Identifier)-including the master.

Baudrate: Set the DeviceNet Baudrate here. Select one of the following: 125kBaud, 250 kBaud and 500 kBaud

Cycle Time: Displays the cycle time of the corresponding highest priority task.

IO-Cycle Time: Sets the cycle time for the IO connections. This value is used as the default value for newly added boxes.

Heartbeat Time : not supported

CX1500-x520

Address: Address of CX1500-x520

Search: Searches for all connected CX1500-x520 channels.

Upload Configuration: Scans the DeviceNet network and adds all found devices (boxes cannot be added). In the case of Beckhoff boxes, reads the configuration precisely. Searches external devices to find the corresponding EDS file.

Firmware: Shows the current firmware version of the CX1500-x520.

Firmware Update: Update the CX1500-x520 card firmware version here.

MAC-ID: Each DeviceNet device requires a unique station number – MAC-ID (Medium Access Identifier)-including the master

Note:

With the CX1500-M520, the MAC-Id / Address is set within the TwinCAT System Manager

With the CX1500-B20, the MAC-Id / Address is set with the Address selector on the module

Baudrate: Set the DeviceNet Baudrate here. Select one of the following: 125kBaud, 250 kBaud and 500 kBaud

Cycle Time: Displays the cycle time of the corresponding highest priority task.

IO-Cycle Time: Sets the cycle time for the IO connections. This value is used as the default value for newly added boxes.

Heartbeat Time : not supported

4.2.2.2 ADS

The screenshot shows the 'ADS' tab in a configuration window. At the top, there are tabs: 'Allgemein', 'FC 520x', 'ADS' (selected), 'General Diag', 'Box States', and 'DPRAM (Online)'. Below the tabs, there is a checked checkbox labeled 'Use Port'. Under this, the 'Port No:' is set to '28673 (0x7001)' with a 'Change...' button next to it. The 'NetId:' is set to '10.14.2.30.2.1'. Below these, the 'Remote Name:' is 'Device 1 (FC520x)'. At the bottom, there is a section for 'Add. NetIds:' with two empty text boxes and 'Add' and 'Delete' buttons to their right.

The ADS section provides information about Port-Number and NetIDs used for TwinCAT ADS Commands.

4.2.2.3 GeneralDiag

The screenshot shows a software window titled 'GeneralDiag' with several tabs: 'Allgemein', 'FC 520x', 'ADS', 'General Diag' (selected), 'Box States', and 'DPRAM (Online)'. The 'General Diag' tab displays two columns of data. The left column contains: 'max. Cycle-Time (µs):' with a value of 2622, 'min. Cycle-Time (µs):' with a value of 164, 'actual Cycle-Time (µs):' with a value of 308, and 'Failed-Cycle-Counter:' with an empty field. The right column contains: 'max. Bus-load (%)' with a value of 3, 'min. Bus-Load (%)' with a value of 3, and 'actual Bus-Load (%)' with a value of 3. Below these fields is a large empty rectangular box, and a 'Reset' button is located in the bottom right corner of the window.

Parameter	Value
max. Cycle-Time (µs):	2622
min. Cycle-Time (µs):	164
actual Cycle-Time (µs):	308
Failed-Cycle-Counter:	
max. Bus-load (%)	3
min. Bus-Load (%)	3
actual Bus-Load (%)	3

Cycle-Time: CycleTime of the DeviceNet-FW

BusLoad.: DeviceNet Bus Load in %

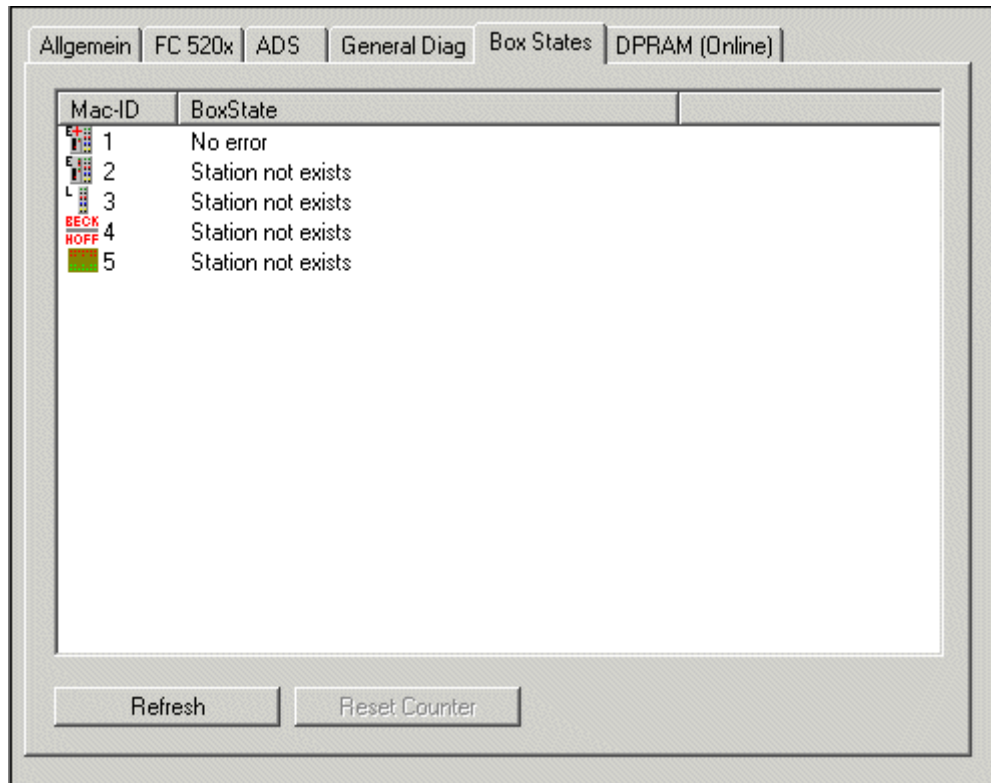
Failed Cycle Counter: This counter increments each time when at the beginning of theTwinCAT-Cycle the last Bus-Cycle was not finished. If the Cycle-Time of the DeviceNet-FW exceeds the CycleTime of the corresponding highest priority task this counter is incremented.

If the Failed Cycle Counter is incremented permanently after the Network-Start, the following has to be checked:

- Cycle-time of the corresponding highest priority task should may adapted to the max. Cycle-Time of the DeviceNet-FW
- Network-Load for the DeviceNet-Master has to be checked. There are may too much DeviceNet Boxes connected to the DeviceNet Master, which could cause a heavy CycleTime for the DeviceNet Master FW.
- Check IO-Cycle Times of attached DeviceNet-Boxes. Some of the IO-Cycle Times of the DeviceNet Boxes are may to fast, which could cause a heavy CycleTime for the DeviceNet Master FW.
- Check DeviceNet Bus-Load

4.2.2.4 BoxStates

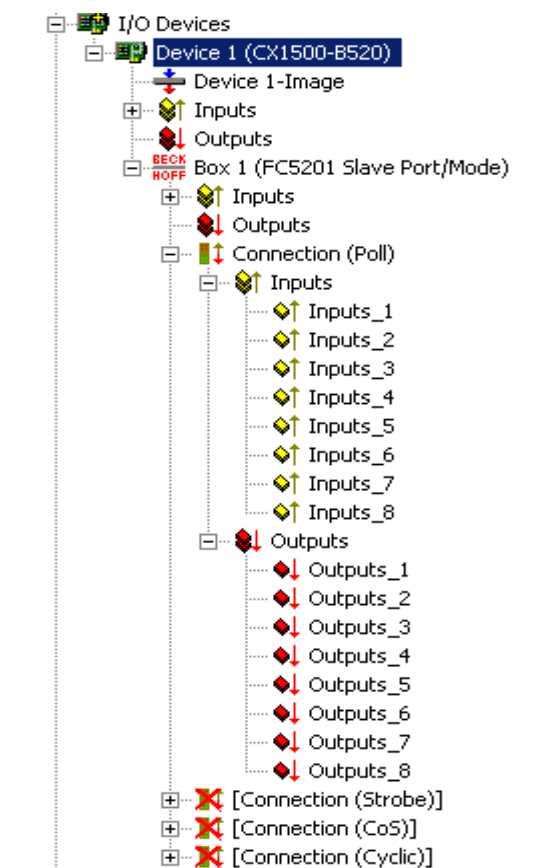
The BoxState section shows the actual state of the connected Boxes for the DeviceNet-Master unit. The BoxState is corresponding to the MAC-State of each DeviceNet-Box:



4.3 DeviceNet Slave

The DeviceNet Slave Functionality is the same for FC520x and CX1500-B520.

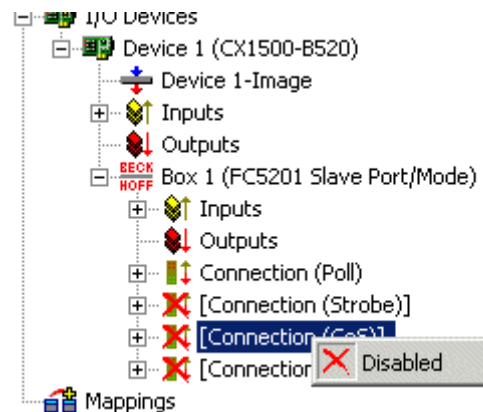
Diagnostic Data is corresponding to the explanations of the Diagnostic Inputs for DeviceNet Devices and DeviceNet Boxes.



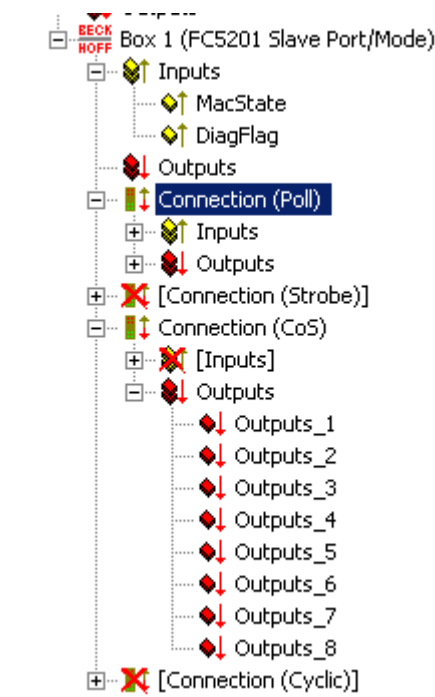
The DeviceNet Slave Port is Pre-Initialized using the IO-Mode Polling. Other IO-Modes can be selected referring the DeviceNet rules by disabling/enabling of the IO-Modes. The Inputs and Outputs Data-Length is set to 8 Bytes per Default. The Data-Lengths can be adjusted as used by the application.

4.3.1 IO-Mode-Selection

The DeviceNet Slave Port is Pre-Initialized using the IO-Mode Polling. Other IO-Modes can be selected referring the DeviceNet rules by disabling/enabling of the IO-Modes:

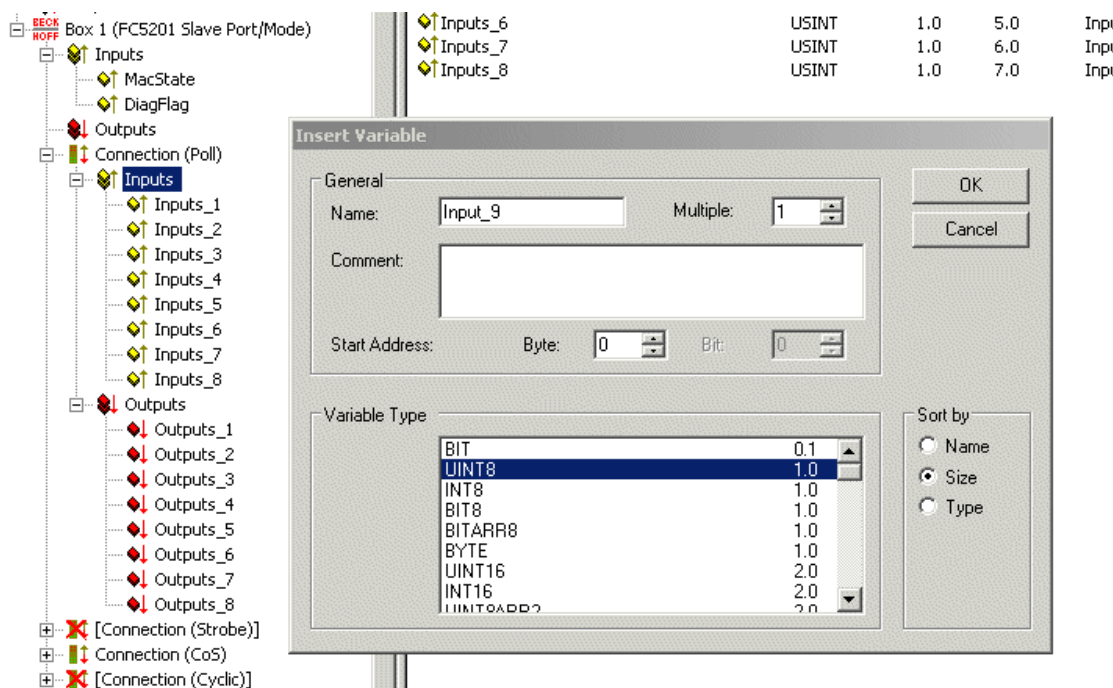


If there are still Inputs/Outputs disabled after selecting other IO-Modes, the referring DeviceNet rules for the IO-Modes are not valid:

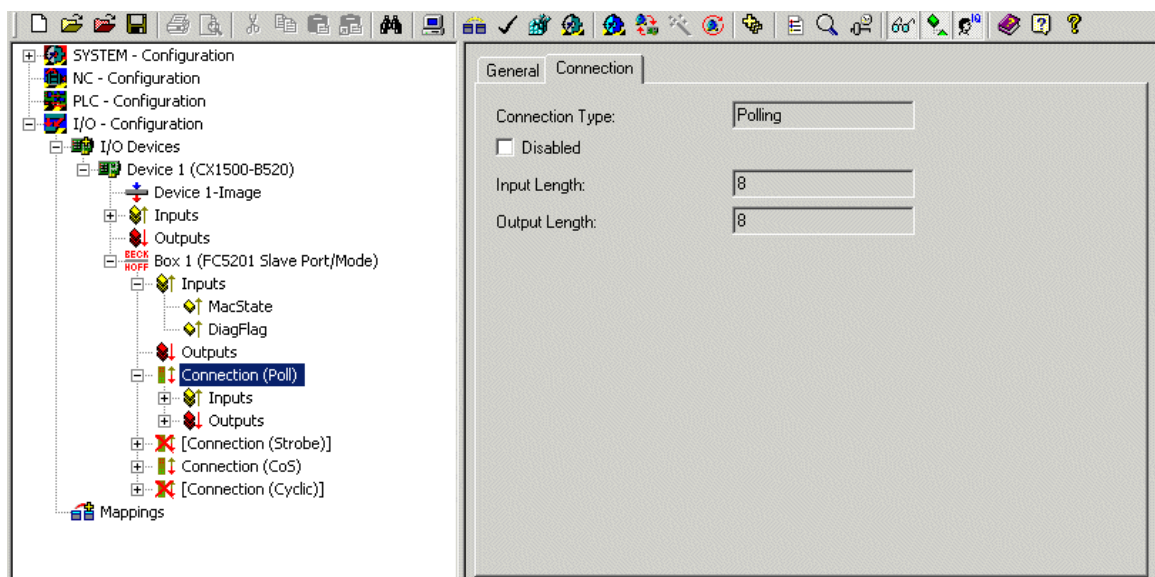


4.3.2 Input/Output Configuration

The Inputs and Outputs can be configured by inserting Variables. This can be done according to the need of the application.



Within DeviceNet, data-lengths are seen as Byte-Streams. The total Number of Bytes have to be configured in the DeviceNet Masters Input and Output Size for its DeviceNet Slaves:



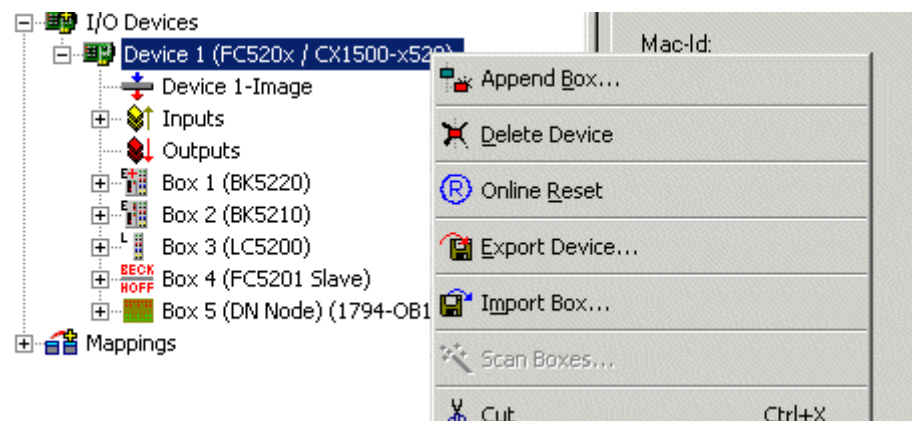
Note: The Data-Length for Inputs and Outputs should not exceed 255 Bytes

4.4 DeviceNet Box

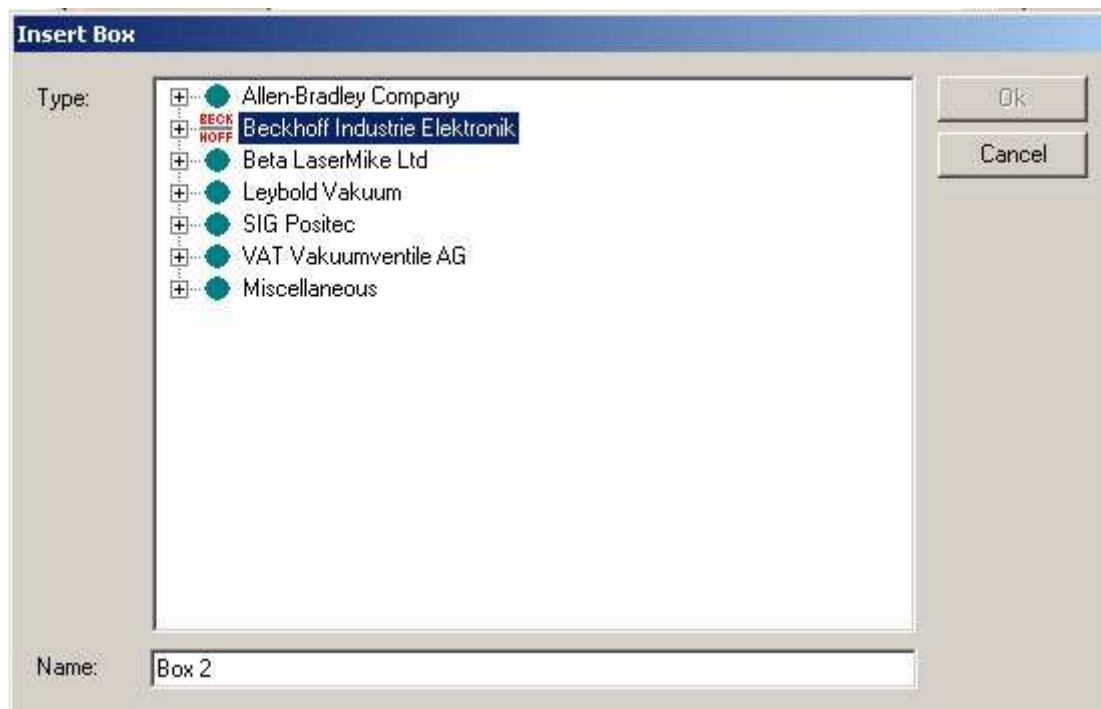
4.4.1 Append Box

Appending a DeviceNet Box can either be executed by running the “Scan-Boxes” routine of the TwinCAT System Manager or by selecting manually the Device out of the list of possible DeviceNet Devices.

Appending the DeviceNet-Box manually is done by e.g. selecting the “DeviceNet-Devices” and apply the right Mouse-Button:



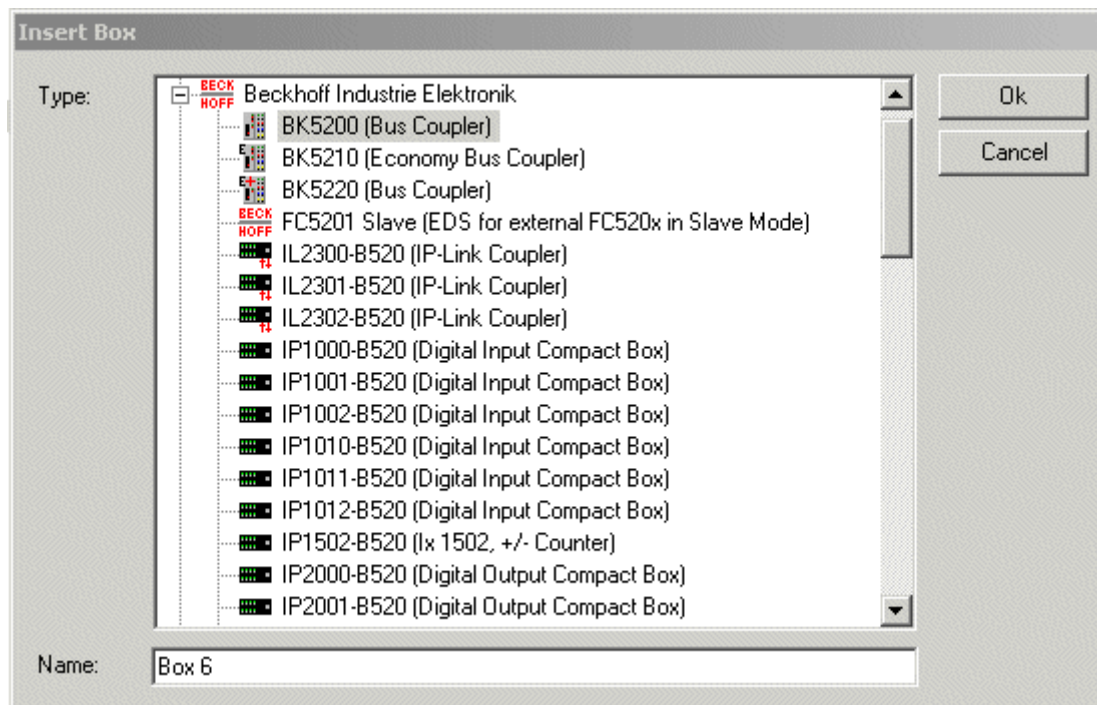
The “Insert-Box” Menu shows the list of available Devices:



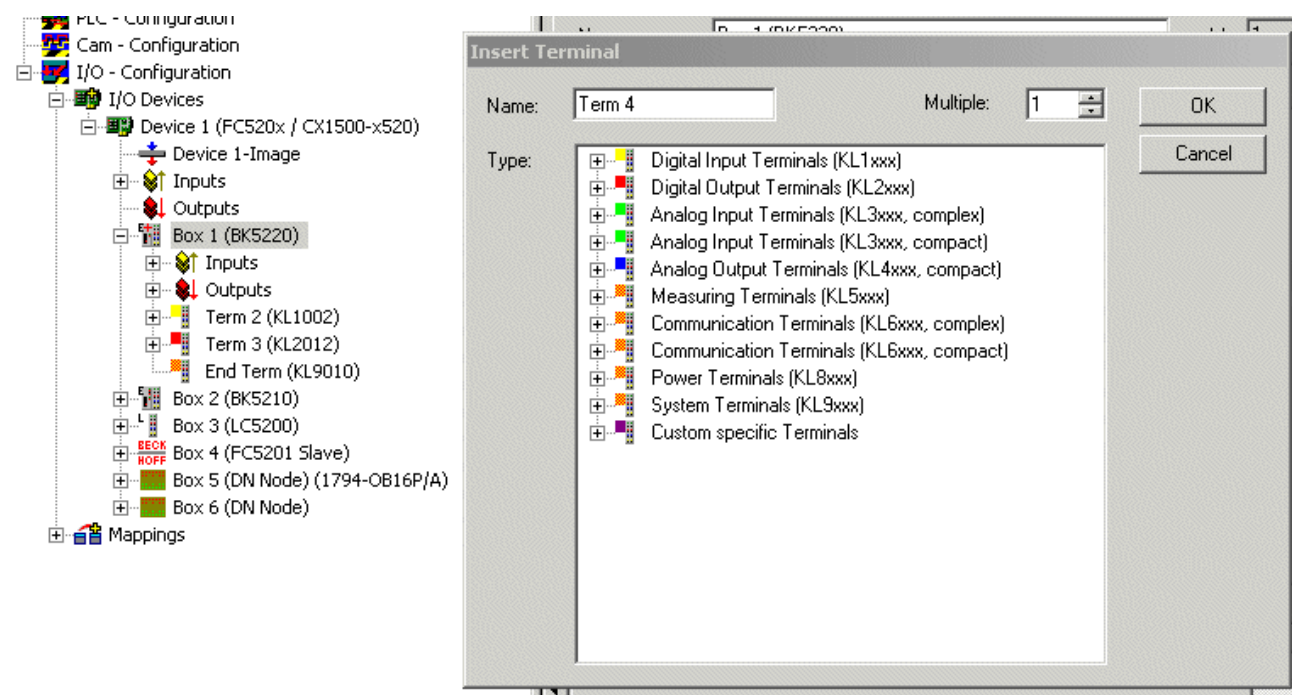
The list is generated with the Information of the EDS-Files stored in:
..\\TwinCAT\\IO\\DeviceNet

4.4.1.1 Insert BK52x0 / IX-B52x

Select the BK52x0 / v IX-B52x within the list of supported Beckhoff-Devices:



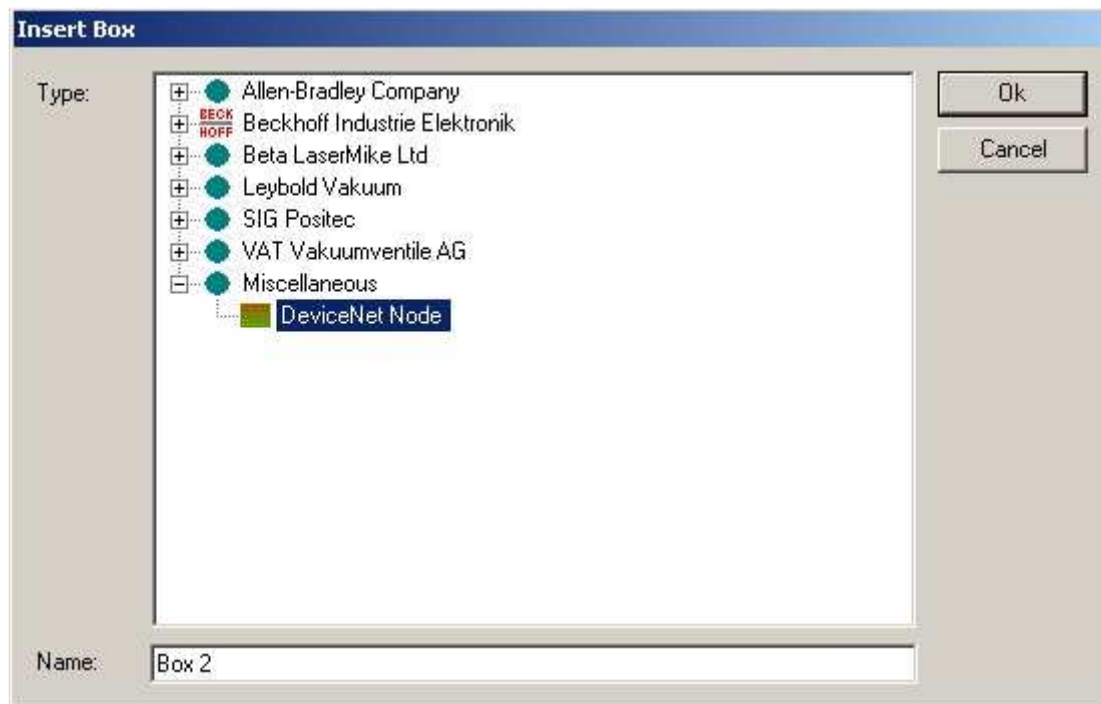
Select the Terminals to be configured for the couplers:



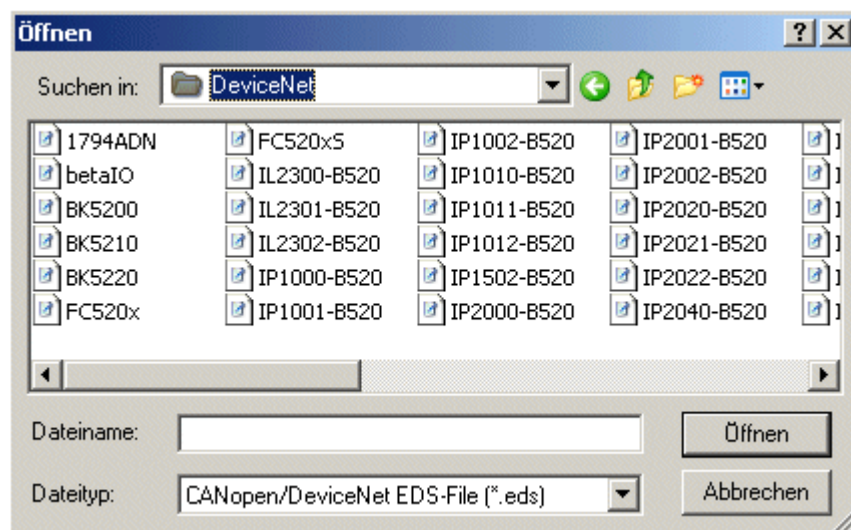
4.4.1.2 Insert DeviceNet Node

Inserting a DeviceNet Node is done by the following steps to be executed:

1. Select a DeviceNet node within the Miscellaneous section



2. Select the EDS-File for the Box to be inserted:



4.4.2 Configuration

4.4.2.1 BK52x0 / IX-B52x / DeviceNet Node

BK52x0 / IX-B52x

The screenshot shows the 'Allgemein' (General) configuration tab for a Beckhoff BK52x0 / IX-B52x device. The interface includes several sections for configuring the DeviceNet node. The 'MAC ID' is set to 1, and the 'Cycle-Time' is 10 ms. Under 'Polled', both 'Produced' and 'Consumed' are set to 'Digital/Ana'. In the 'Bit-Strobed' section, 'Produced' is 'Not Used' and 'Use Consumed Bit' is unchecked. The 'Electronic Key' section has four unchecked checkboxes: 'Check Vendor-ID', 'Check Device Type', 'Check Product Code', and 'Check Major Revision'. The 'Auto Device Rec. (ADR)' section has two unchecked checkboxes: 'Config. Recovery' and 'Address Recovery'. The 'Change of State / Cyclic' section has 'Produced' and 'Consumed' set to 'Not Used', 'Change of State' is selected, 'Heartbeat-Rate/Send-Rate' is 100 ms, 'Inhibit-Time' is 0 ms, 'Acknowledge' is checked, 'Acknowledge-Timeout' is 16 ms, and 'Acknowledge-Retry-Limit' is 1. At the bottom, 'K-Bus Update' is 150 μs, and there is a 'Firmware Update (via COMx) ...' button.

MAC Id: Sets the MAC-ID of the DeviceNet participant (between 0 and 63). This value must comply with the value set at the Bus Coupler.

Cycle Time: Sets the cycle time for the IO connection (Polled and Bit-Strobe). This value is added to the Expected Packet Rate (EPR) attributes of the DeviceNet slave and acts as a timeout monitor for IO connections.

Electronic Key: Serves to check the devices within the network at the system StartUp. The electronic key is read from the devices at every system StartUp and compared with the saved configuration.

Polled: Produced/Consumed: Activation of the "Polling" operating mode, cyclical writing and reading of IO data. Setting of the data content of the data transmitted via the polled IO connections. You can choose from digital data, analogue data or both. The selection depends upon the BK52xx terminal arrangement.

Bit-Strobed: Produced/Consumed: Activation of the "Bit Strobe" Operating Mode. With a broadcast message all nodes are requested to send their bit strobe message (up to 7 bytes input or status data). Setting of the data content of the data transmitted via the bit-strobed IO connections. You can choose between digital data or diagnostic data.

Change of State / Cyclic:

- Produced/Consumed: Setting of the data content of the data transmitted via the change of state/cyclical IO connections. You can choose from digital data, analogue data or both. The selection depends upon the BK52xx terminal arrangement.

- Change of State / Cyclic: Selecting the Corresponding Operating Mode

- Heartbeat Rate / Scan Rate: In the "Change of State" mode the heartbeat rate gives the cycle time of the cyclical send of the lower-level (i.e. in addition to the event driven) IO data. In the "Cyclic" operating mode the scan rate gives the cycle time of the IO data send.

Inhibit time: Delay period in the "Change of State" operating mode inserts this pre-set delay period after a change of state before the IO data send.

Acknowledge Timeout: Time before the re-send in the event of faulty acknowledgement of a change of state / cyclical message.

Acknowledge Retry Limit: Maximum number of re-sends until IO connection goes into error mode.

K-Bus Update: Calculates the anticipated duration of a complete update of the terminal bus (according to the number of connected terminals). This is not to be seen as the response time of the DeviceNet Node to DeviceNet IO-Requests.

Auto Device Replacement (ADR): not supported

DeviceNet-Node

The screenshot shows the 'DeviceNet-Node' configuration window. It features several tabs: 'Allgemein', 'DeviceNet-Node', 'Startup Attribute', 'ADS', and 'Diag'. The 'DeviceNet-Node' tab is selected. The configuration is organized into several sections:

- MAC ID:** A numeric field set to 5.
- Cycle-Time:** A numeric field set to 10, followed by 'ms'.
- Polled:** Two checkboxes, 'Produced' and 'Consumed', both of which are unchecked.
- Bit-Strobed:** Two checkboxes, 'Produced' and 'Use Consumed Bit', both of which are unchecked.
- Electronic Key:** A group box containing four checkboxes: 'Check Vendor-ID', 'Check Device Type', 'Check Product Code', and 'Check Major Revision'. All are unchecked.
- Auto Device Rec. (ADR):** A group box containing two checkboxes: 'Config. Recovery' and 'Address Recovery'. Both are unchecked.
- Change of State / Cyclic:** A group box containing:
 - Two checkboxes, 'Produced' and 'Consumed', both checked.
 - Two radio buttons, 'Change of State' (selected) and 'Cyclic'.
 - Heartbeat-Rate/Send-Rate:** A numeric field set to 100, followed by 'ms'.
 - Inhibit-Time:** A numeric field set to 0, followed by 'ms'.
 - Acknowledge:** A checked checkbox.
 - Acknowledge-Timeout:** A numeric field set to 16, followed by 'ms'.
 - Acknowledge-Retry-Limit:** A numeric field set to 1.

MAC Id: Sets the MAC-ID of the DeviceNet participant (between 0 and 63). This value must comply with the value set at the Bus Coupler.

Cycle Time: Sets the cycle time for the IO connection(Polled and Bit-Strobe). This value is added to the Expected Packet Rate (EPR) attributes of the DeviceNet slave and acts as a timeout monitor for IO connections.

Electronic Key: Serves to check the devices within the network at the system StartUp. The electronic key is read from the devices at every system StartUp and compared with the saved configuration.

Polled: Produced/Consumed: Activation of the "Polling" operating mode, cyclical writing and reading of IO data. Setting of the data content of the data transmitted via the polled IO connections. You can choose from digital data, analogue data or both. The selection depends upon the BK52xx terminal arrangement.

Bit-Strobed: Produced/Consumed: Activation of the "Bit Strobe" Operating Mode. With a broadcast message all nodes are requested to send their bit strobe message (up to 7 bytes input or status data). Setting of the data content of the data transmitted via the bit-strobed IO connections. You can choose between digital data or diagnostic data.

Change of State / Cyclic:

- Produced/Consumed: Setting of the data content of the data transmitted via the change of state/cyclical IO connections. You can choose from digital data, analogue data or both. The selection depends upon the BK52xx terminal arrangement.

- Change of State / Cyclic: Selecting the Corresponding Operating Mode

- Heartbeat Rate / Scan Rate: In the "Change of State" mode the heartbeat rate gives the cycle time of the cyclical send of the lower-level (i.e. in addition to the event driven) IO data. In the "Cyclic" operating mode the scan rate gives the cycle time of the IO data send.

Inhibit time: Delay period in the "Change of State" operating mode inserts this pre-set delay period after a change of state before the IO data send.

Acknowledge Timeout: Time before the re-send in the event of faulty acknowledgement of a change of state / cyclical message.

Acknowledge Retry Limit: Maximum number of re-sends until IO connection goes into error mode.

K-Bus Update: Calculates the anticipated duration of a complete update of the terminal bus (according to the number of connected terminals). This is not to be seen as the response time of the DeviceNet Node to IO-Requests.

Auto Device Replacement (ADR): not supported

4.4.2.2 Startup-Attribute

Attributes/Parameters sent to the Box at StartUp of the Network are displayed/managed on this page. Other entries can be managed using "New", "Delete" and "Edit":

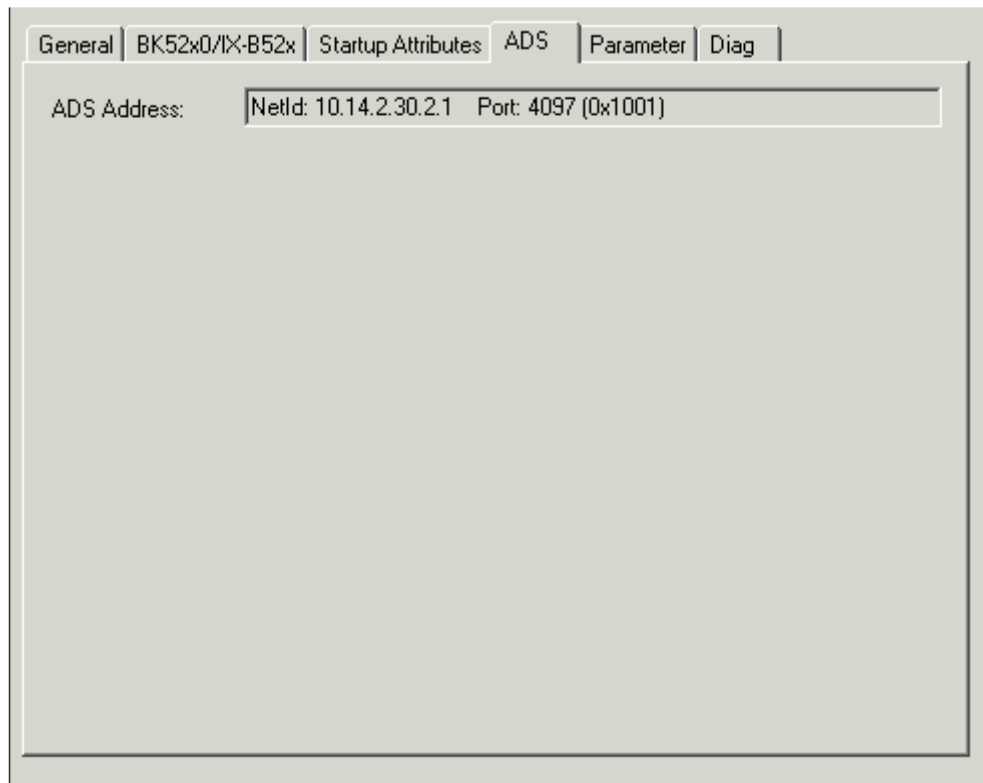
Class/Inst./Attr. Id	Length	Value	Name
100.1.10	1	01	IO Error Action

New... Delete... Edit...

Start-Up Attributes are loaded into the DeviceNet Box at the Beginning of each Network-Startup.. The values are loaded before the IO-Connections are started.

4.4.2.3 ADS

In order to be able to read and write attributes during the running time (e.g. from the PLC), the Box (e.g. Bus Coupler) can be allocated via an ADS port. The ADS Port can be used to read / write attributes via ADS read requests / ADS write requests:



The ADS IndexGroup contains the ClassId and the ADS IndexOffset contains InstanceId and AttributeId (InstanceId * 256 + AttributeId).

The following ADS-Commands are used to exchange DeviceNet Explicit-Messages:

ADS Command	DeviceNet Service (ServiceCode)	Index-Group	IndexOffset
ADSRead	Get_Attribute_Single (0x0E)	ClassId	(InstanceId * 256 + AttributeId)
ADSWrite	Set_Attribute_Single (0x10)	ClassId	(InstanceId * 256 + AttributeId)
ADSReadWrite	Common DeviceNet Service	ClassId	(InstanceId * 256 + ServiceId)

4.4.2.4 Parameter

The parameters are read from the EDS-File when appending the box. If the system has not started up, the EDS default value is always displayed under the value input:

Num	Name	Flags	Value
1	IO Error Action	u	Leave Local I/O Cycle + Reset O...
2	Input Data Bit Strobe	u	Discrete I/O
3	Input Size Poll Mode	ur	0 (0x0) Byte
4	Input Size COS/Cyc Mode	ur	0 (0x0) Byte
5	Data Size Bit Strobe	ur	0 (0x0) Byte
6	Output Size Poll/COS/Cyc	ur	0 (0x0) Byte
7	BK5220 Status	urm	0x0
8	Terminal No.	u	Coupler
9	Table No.	u	Table 0: Coupler or 1. Channel (T...
10	Register No.	u	0 (0x0)
11	Get Register data+status	ur	0x0
12	Set Register data	u	0x0
13	Device Diagnostics	u	OFF

Flags: u = unknown value; default value displayed, r = read only
m = possibly modified by device in real time, * = modified by user

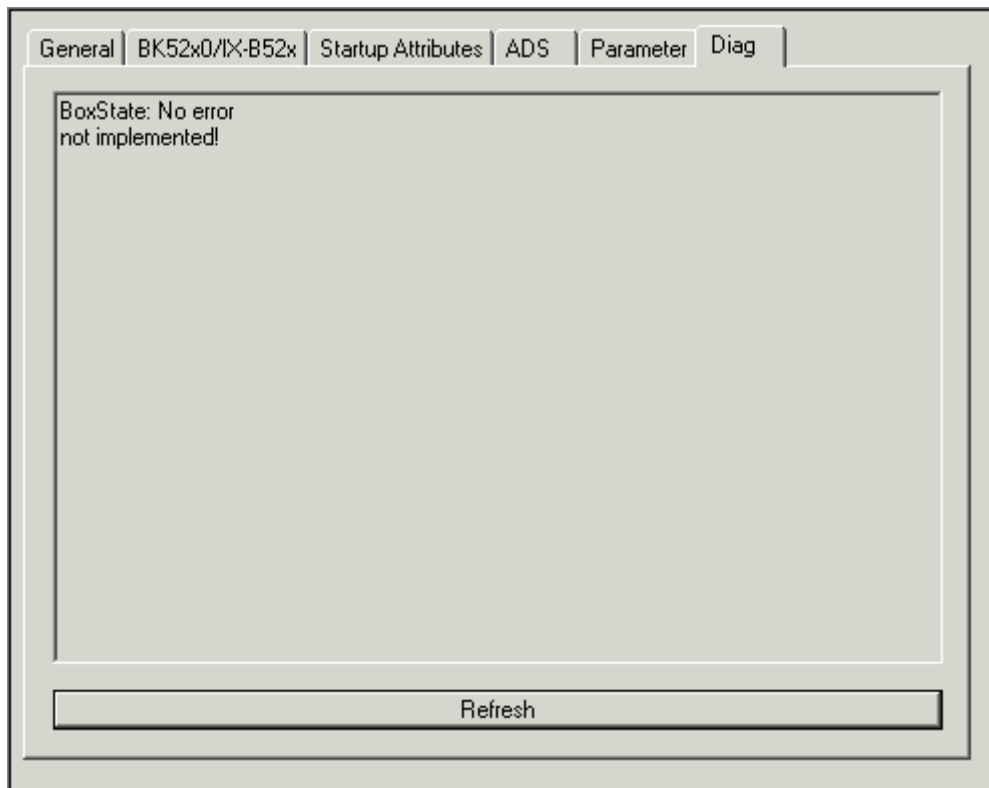
Write Read Set Default Select All

Copy to Startup Attributes All

When configuring a DeviceNet node, an electronic data sheet (EDS) is usually provided by the manufacture of that device to assist in this task. An EDS file is a text file that describes properties of a particular DeviceNet node. It includes the number of bytes that are transmitted to the node (output information) and the number of bytes that are received from the node (input and status information). Furthermore it includes a Parameter sections, which is analyzed by the SystemManger and displayed within this section.

4.4.2.5 Diag

The Diag-Section shows the actual MAC-State of the DeviceNet-Node:



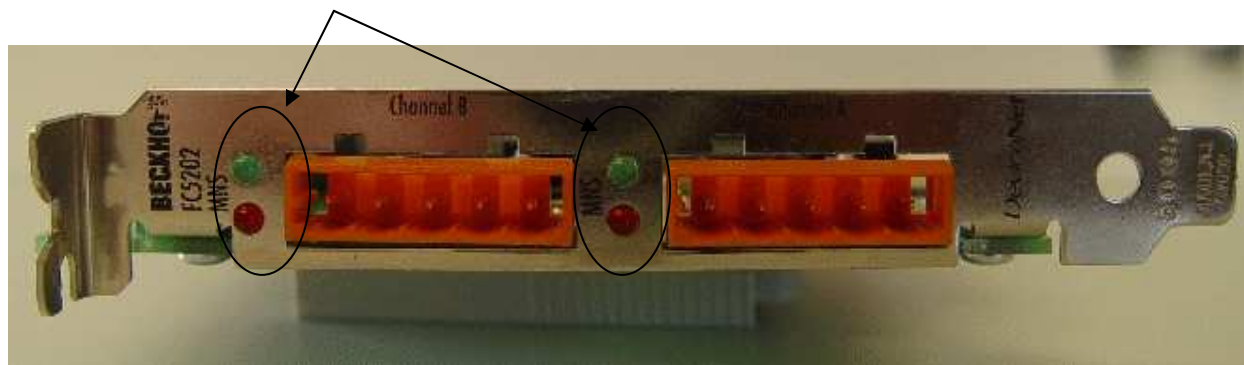
Not implemented means in this content that there is no more diagnostic data available within this section.

5 Error Handling and Diagnosis

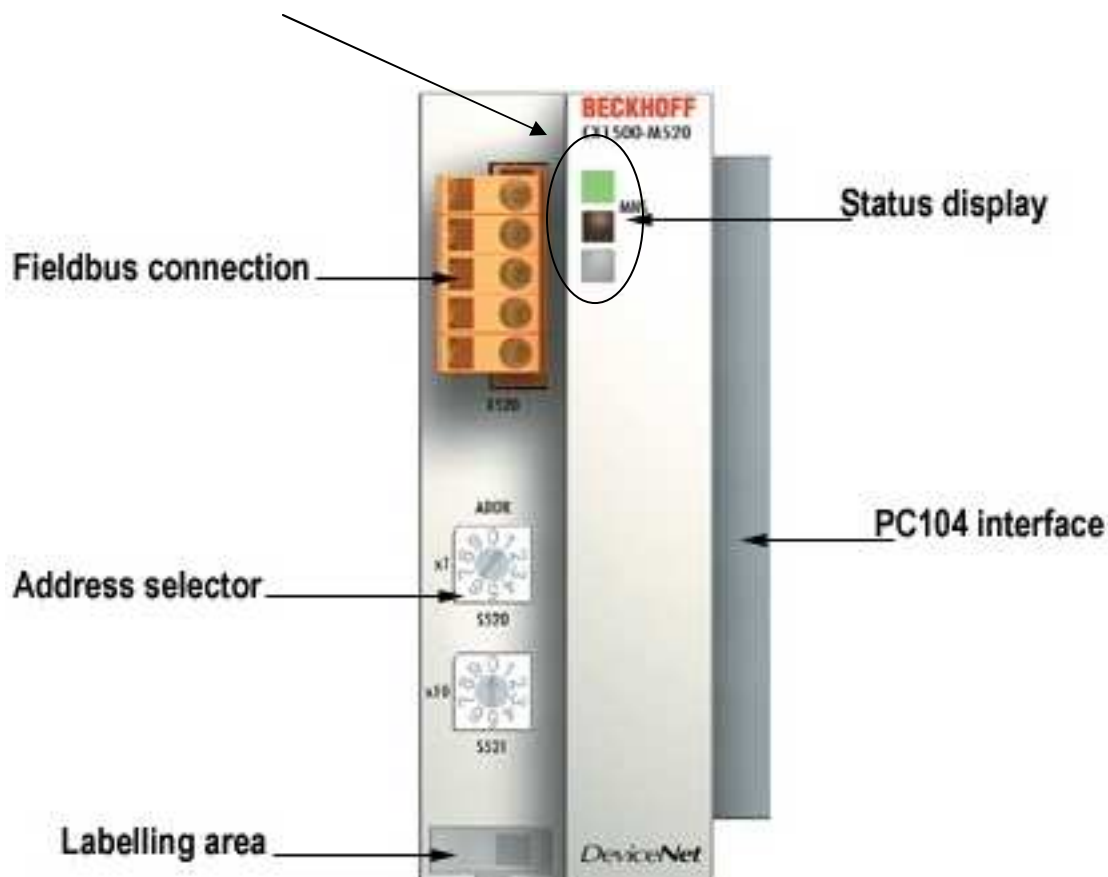
5.1 LEDs

The LEDs on the FC5201 / CX1500-x520 are implemented as DeviceNet Module-Network-Status LEDs. For each channel there is a green and a red colour LED next to the channels DeviceNet connector. The LEDs are displaying a different behaviour in Master and Slave Mode :

5.1.1 LEDs on FC520x



5.1.2 LEDs on CX1500-x520



5.1.3 Master-Functionality

LED	Description	Troubleshooting
Green Flashing	Master in online, has finished the Duplicate MacId Check	None
Green on	Master is online and communicates with its configured Slaves	None
Red Flashing	Master has lost communication with one of the configured Slaves	Inspect the devices, verify connections, check cabling
Red on	DeviceNet Bus OFF, DeviceNet Voltage Error, Master failed Duplicate MacId Check	Check Baudrate and cabling, Master is may not able to set up his Duplicate Mac Id messages, Check DeviceNet Voltage (24 Volt) at DeviceNet Connector

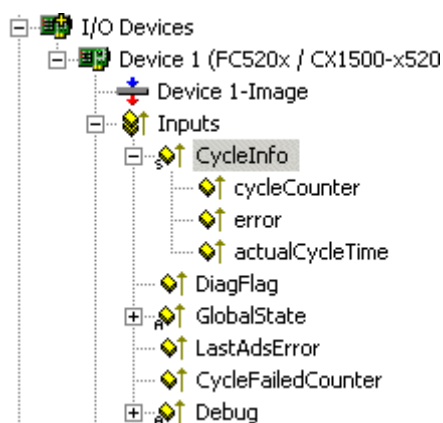
5.1.4 Slave-Functionality

LED	Description	Troubleshooting
Green Flashing	Slave port has finished the Duplicate MacId Check (Network OK), Slave Port is not communicating with its Master	None
Green on	Slave port is online and communicates with its Master	None
Red Flashing	Slave port has lost communication with its Master, Timeout of Slave-Port	Inspect the Master device, verify connections, check cabling
Red on	DeviceNet Bus OFF, DeviceNet Voltage Error, Slave port failed Duplicate MacId Check	Check Baudrate and cabling, Slave Port is may not able to set up his Duplicate Mac Id messages, Check DeviceNet Voltage (24 Volt) at DeviceNet Connector

5.2 Device Diagnostics

Note: It is mandatory and recommended to take all the diagnostic Inputs of the DeviceNet Device into account.

5.2.1 Common Inputs



cycleCounter: DeviceNet-FW increments this counter once after each cycle

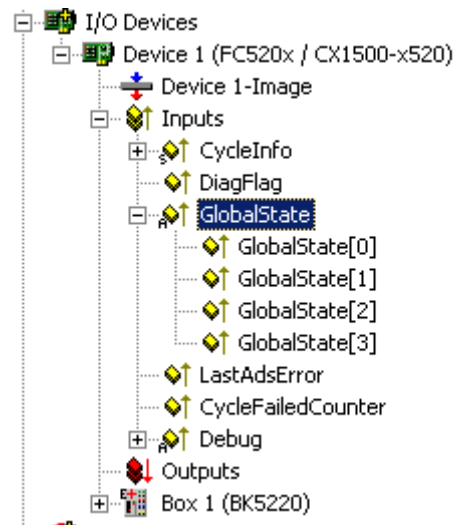
error: indicates the number of boxes with a BoxState unequal zero

actualCycleTime: reserved for future use

DiagFlag: Shows whether the diagnostics information on the card has changed. This can be read off using ADS Read. For that purpose, specify the net ID of the FC520x / CX1500-x520, the port number 200 and the IndexGroup 0xF100. The IndexOffset and the length then relate to the diagnostic data.

CycleFailedCounter: This counter increments each time when at the beginning of the TwinCAT-Cycle the last Bus-Cycle was not finished

5.2.2 GlobalState



5.2.2.1 GlobalState[0]

General Status of FC520x / CX1500-X520 within the System Manager

Error Code (hex)	Description	Troubleshooting
0x00	FC520x is in state RUN	None
0x01	FC520x is in state RESET	Start TwinCAT System, Check TwinCAT System Status
0x02	FC520x is in state OFFLINE	Start TwinCAT System, Check TwinCAT System Status
0x03	FC520x is in state STOP	Start TwinCAT System, Check TwinCAT System Status

5.2.2.2 GlobalState[1]

Operating Status of the FC5201 / CX1500-X520 referring to the DeviceNet functions

Error Code (hex)	Description	Troubleshooting
0x00	Status Operational, PLC-Run Mode, DeviceNet Master is in Run Mode and exchanging IO Data with its Slaves	None
0x01	Status Operational, PLC-Idle Mode, DeviceNet Master is in Idle Mode and is not exchanging IO Data with its Slaves. Only idle messages (including no IO-Data) where exchanged	None, check if the PLC is running and if the variables are mapped correct to a one of the tasks
0x02	Duplicate MacId Fault, FC520x / CX1500-x520 has failed during Duplicate MacId Check	Check MACIds of all installed nodes for duplicate addresses. Check Baudrate, check cabling
0x03	Status SelfTest	None
0x04	Status StandBy	None
0x05	Status Major Recoverable Fault	Inspect the master device, verify connections, check cabling
0x06	Status Minor Recoverable Fault	Inspect the master device, verify connections, check cabling
0x07	DeviceNet Voltage Error	Check DeviceNet Voltage (24 Volt) at the DeviceNet connector, see connector description.

5.2.2.3 GlobalState[2]

CAN Network Status of the FC5201 / CX1500-X520.

Note: This Status-Variable is Bit-Encoded

Error Code (hex)	Description	Troubleshooting
0x00	CAN-Controller is in normal operating mode	None
0x01	CAN-Bus OFF, CAN-Controller is in Bus-Off Status	Check Cabling, Check Baudrates, Check Bus Termination
0x02	CAN-Controller has reached the Error Warning Limit	Check Cabling, Check Baudrates, Check Bus Termination. DeviceNet Device is may the only Device within the Network
0x04	CAN Controller is in Overrun Status, FC520x has lost one of his messages	Reduce the IO-Cycle Time of the appended nodes, Check DeviceNet Busload

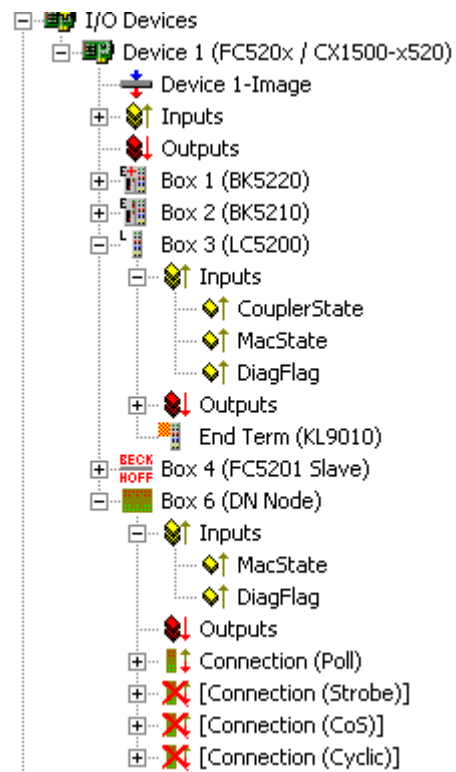
5.2.2.4 GlobalState[3]

CAN/DeviceNet Bus Load in %

5.3 Box Diagnostics

Note: It is mandatory and recommended to take all the diagnostic Inputs of the DeviceNet Boxes into account.

The following Diagnostic Inputs are available for DeviceNet Boxes:



5.3.1 CouplerState (BK52x0, ILX-52x)

Note: This Status-Variable is Bit-Encoded

Error Code (hex)	Description	Troubleshooting
0x00	No Error	None
0x01	IO Error	Data exchange between coupler and terminals has faulted. Check the IO error LEDs at the coupler, see error code in coupler manual
0x02	Coupler configuration error, devices non-volatile parameters are not valid	Set Manufacturers Setting e.g. with KS2000 or via register communication and reset coupler.
0x08	Diagnoses of analogue terminals, this feature has first to be activated via KS200 or register communication	Read the terminal diagnoses via explicit messages or via the Bit-Strobe Connection. The Bit is resetted after reading of the diagnosis data
0x80	Fieldbus Error / Idle Mode	Check Communication Parameter of the IO Connections. Check if the Device is in the Idle mode. The bit is reseted if the device receives valid IO data

5.3.2 MacState

Error Code	Description	Troubleshooting
0	No error	None
1	Node is deactivated by the scanner, node is no longer in the masters scan-list For Slave Devices it means that there is no Data-Exchange between the Master and the Slave. The Master has released the DeviceNet Slave	None, check system configuration, check if a new configuration was correctly saved to the registry
2	No data exchange between node and DeviceNet Master, node access timeout	Inspect the field device, verify connections, check cabling
18	Node is configured, ready for data exchange	None
42	Electronic Key Error: Vendor Id	Make sure that the nodes key parameters matches the settings. Check Node Identity for the nodes address
43	Electronic Key Error: Device Type	Make sure that the nodes key parameters matches the settings. Check Node Identity for the nodes address
44	Electronic Key Error: Product Code	Make sure that the nodes key parameters matches the settings. Check Node Identity for the nodes address
45	Electronic Key Error: Revision	Make sure that the nodes key parameters matches the settings. Check Node Identity for the nodes address
46	Error writing start-up attributes	Make sure that the nodes start-up parameters matches the ones accessible within the Box
47	Wrong produced IO-Data length	Check number of Bytes to be produced by the field device, check field devices IO configuration
48	Wrong consumed IO-Data length	Check number of Bytes to be consumed by the field device, check field devices IO configuration
49	Idle Mode (for Slave Devices): no valid IO-Data is exchanged via DeviceNet	Check if the Master is running in Idle Mode

5.3.3 DiagFlag

Code	Description	Troubleshooting
0	No Error, there is no Diagnostic Data available	None
1	Node has entered a DeviceNet specific error during explicit data exchange: - Explicit Messaging Error	Check Parameter / Attributes /services of the node. Check programming of explicit access to the node.

6 Appendix

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.

6.1 Support and Service

Beckhoff Support

Support offers you comprehensive technical assistance, helping you not only with the application of individual BECKHOFF products, but also with other, wide-ranging services:

- world-wide support
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Hotline: +49(0)5246/963-157
Fax: +49(0)5246/963-199
e-mail: support@beckhoff.com

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Hotline: +49(0)5246/963-460
Fax: +49(0)5246/963-479
e-mail: service@beckhoff.com

You will find further support and service addresses on our Internet pages under <http://www.beckhoff.com>.

BECKHOFF Headquarters

BECKHOFF Industrie Elektronik
Eiserstr. 5
33415 Verl
Germany

Hotline: +49(0)5246/963-0
Fax: +49(0)5246/963-198
e-mail: info@beckhoff.com

The addresses of BECKHOFF's branch offices and representatives round the world can be found on her internet pages:
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You will also find further documentation for BECKHOFF components there.