DeviceNet Coupler BK5200, BK5210, LC5200

Technical Documentation

Version 1.3
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BECKHOFF

Please note the following

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

Safety requirements 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.

Table of contents

Foreword

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.

Liability Conditions

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. None of the statements of this manual represents a guarantee (Garantie) in the meaning of § 443 BGB of the German Civil Code or a statement about the contractually expected fitness for a particular purpose in the meaning of § 434 par. 1 sentence 1 BGB. 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.

Delivery conditions

In addition, the general delivery conditions of the company Beckhoff Automation GmbH apply.

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Safety Instructions

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 Beckhoff Automation GmbH.

Description of safety symbols

The following safety symbols are used in this documentation. They are intended to alert the reader to the associated safety instructions..

Danger	This symbol is intended to highlight risks for the life or health of personnel.
Attention	This symbol is intended to highlight risks for equipment, materials or the environment.
Note	This symbol indicates information that contributes to better understanding.

Basic Principles

The Beckhoff Bus Terminal System

Up to 64 Bus Terminals

each having 2 I/O channels for each signal form

The Bus Terminal system is the universal interface between a fieldbus system and the sensor / actuator level. A unit consists of a Bus Coupler as the head station, and up to 64 electronic series terminals, the last one being an end terminal. For each technical signal form, terminals are available each having two I/O channels, and these can be mixed in any order. All the terminal types have the same mechanical construction, so that difficulties of planning and design are minimised. The height and depth match the dimensions of compact terminal boxes.

de-centralised wiring of the I/O level

IPC as controller

Fieldbus technology allows more compact forms of controller to be used. The I/O level does not have to be brought to the controller. The sensors and actuators can be wired de-centrally, using minimum cable lengths. You can locate the controller installation anywhere within the plant. The use of an Industrial PC as the controller means that the operating and observing element can be implemented in the controller's hardware. The controller can therefore be located at an operating panel, in a control room, or at some similar place. The Bus Terminals form the de-centralised input/output level of the controller in the control cabinet and the subsidiary terminal boxes. The power sector of the plant is also controlled over the bus system in addition to the sensor/actuator level. The Bus Terminal replaces the conventional series terminal as the wiring level in the control cabinet. The control cabinet can have smaller dimensions.

Bus Couplers for all usual bus systems

The Beckhoff Bus Terminal system unites the advantages of a bus system with the possibilities of the compact series terminal. Bus Terminals can be driven within all the usual bus systems, thus reducing the controller parts count. The Bus Terminals then behave like conventional connections for that bus system. All the performance features of the particular bus system are supported.

Standard C - rail assembly

The easy, space-saving, assembly on a standard C-rail, and the direct wiring of actuators and sensors, without cross-connections between the terminals, standardises the installation. The consistent labelling scheme also contributes.

The small physical size and the great flexibility of the Bus Terminal system allows it to be used wherever a series terminal is also used. Every type of connection, such as analog, digital, serial or the direct connection of sensors can be implemented.

Modularity

The modular assembly of the terminal strip with Bus Terminals of various functions limits the number of unused channels to a maximum of one per function. The presence of two channels in one terminal is the optimum compromise of unused channels and the cost of each channel. The possibility of electrical isolation through potential feed terminals also helps to keep the number of unused channels low.

Display of the channel state

The integrated LEDs show the state of each channel at a location close to the sensors and actuators.

K-Bus

End terminal

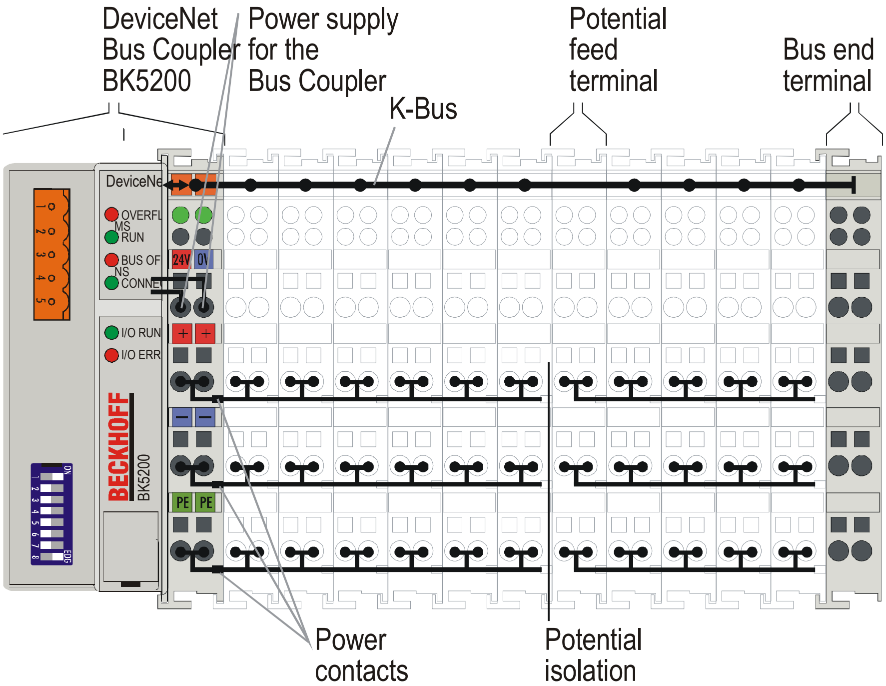
The K-Bus is the data path within a terminal strip. The K-Bus is led through from the Bus Coupler through all the terminals via six contacts on the terminals‘ side walls. The end terminal terminates the K-Bus. The user does not have to learn anything about the function of the K-Bus or about the internal workings of the terminals and the Bus Coupler. Many software tools that can be supplied make project planning, configuration and operation easy.

Potential feed terminals for electrically isolated groups

The operating voltage is passed on to following terminals via three power contacts. You can divide the terminal strip into arbitrary isolated groups by means of potential feed terminals. The feed terminals play no part in the control of the terminals, and can be inserted at any locations within the terminal strip.

Up to 64 terminals may be located in a terminal strip, including the potential feed terminals and end terminal.

The principle of the Bus Terminal



Bus couplers for various fieldbus systems

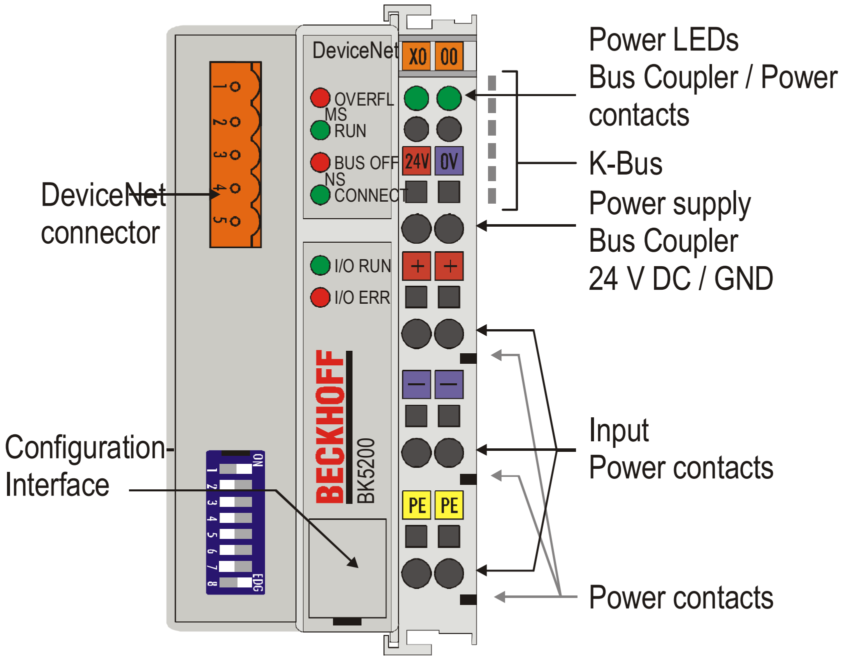
Various Bus Couplers can be used to couple the electronic terminal strip quickly and easily to different fieldbus systems. It is also possible to convert to another fieldbus system at a later time. The Bus Coupler performs all the monitoring and control tasks that are necessary for operation of the connected Bus Terminals. The operation and configuration of the Bus Terminals is carried out exclusively by the Bus Coupler. Fieldbus, K-Bus and I/O level are electrically isolated.

If the exchange of data over the fieldbus fails for a time, counter states are retained, digital outputs are cleared, and analogue outputs take a value that can be separately configured for each output when commissioning.

The interfaces

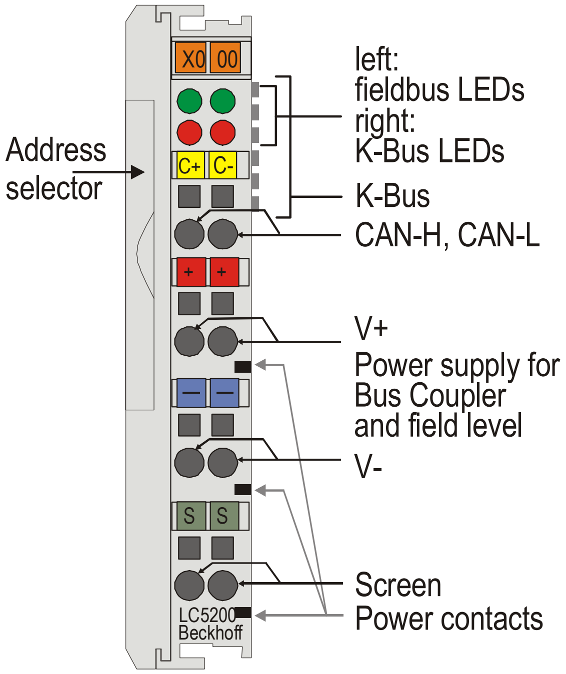
A Bus Coupler has six different methods of connection. These interfaces are designed as plug connectors and as spring-loaded terminals.

The DeviceNet Coupler BK5200 / BK5210



The LC5200 Bus Coupler integrates the bus connection into the spring-loaded terminals.

The DeviceNet coupler LC5200



Power supply

BK5200, BK5210: 24 V DC to the topmost terminals "24 V" and "0 V"

The Bus Couplers require a 24 V DC supply for their operation. In the case of the BK52x0 Bus Couplers the connection is made by means of the upper spring-loaded terminals labelled "24 V" and "0 V". This supply voltage feeds not only the Bus Coupler electronics via the K-Bus, but also the Bus Terminals. In the BK52x0 Bus Couplers the voltage supply for the bus coupler electronics and that of the K-bus are electrically isolated from the field level potentials.

LC5200:
24V DC to the centre terminal pairs

The LC5200 Bus Coupler is supplied via the two central terminal pairs. The power contacts pass the supply voltage on to the field level.

Power contact feed points

Bottom 3 terminal pairs for feed

Maximum 24 V

Maximum 10 A

The bottom six connections with spring-loaded terminals can be used to feed the supply for the peripherals. The spring-loaded terminals are joined in pairs to a power contact. The feed for the power contacts has no connection to the voltage supply for the bus coupler (BK52x0). The design of the feed permits voltages of up to 24 V. The assignment in pairs and the electrical connection between feed terminal contacts allows the connection wires to be looped through to various terminal points. The current drawn from the power contact must not exceed 10 A for long periods. The current rating between two spring-loaded terminals is identical to that of the connecting wires.

Power contacts

Spring contacts on the side

On the right hand face of the Bus Coupler there are three spring contacts for the power contact connections. The spring contacts are hidden in slots so that they can not be accidentally touched. By attaching a Bus Terminal the blade contacts on the left hand side of the Bus Terminal are connected to the spring contacts. The tongue and groove guides on the top and bottom of the Bus Coupler and of the Bus Terminals guarantees that the power contacts mate securely.

Fieldbus connection

BK5200, BK5210: 5 pin open style connector

The BK52x0 Bus Couplers have a recessed front surface on the left hand side. The DeviceNet connection plug can be inserted here. A full description of the fieldbus interfaces is found elsewhere in this manual.

LC5200: Bus connection via spring loaded terminals

In the LC5200 Bus Coupler the bus is connected directly at the upper terminal pair.

Configuration interface

Serial interface under the front cover

The BK52x0 Bus Couplers have an RS232 interface at the bottom of the front face, whereas on the LC5200 it is located under the cover on the side. The miniature connector can be joined to a PC with the aid of a connecting cable and the KS2000 configuration software. The interface allows the analog channels to be configured and also permits firmware updating.

The functionality of the configuration interface can also be reached via the fieldbus using the object attributes for the register communication.

K-Bus contacts

6 contacts on the side

In order to connect the Bus Coupler and Bus Terminals the Bus Coupler has gold contacts on the right hand side. When the Bus Terminals are pushed together the gold contacts automatically make the connection between the Bus Terminals. The voltage supply to the K-Bus electronics in the Bus Terminals and the data exchange between the Bus Coupler and the Bus Terminals is carried out by the K-Bus. A part of the data exchange takes place via a ring structure within the K-Bus. Opening the K-Bus, e.g. by pulling out one of the Bus Terminals, opens the ring. Data exchange is no longer possible. Special mechanisms nevertheless allow the Bus Coupler to identify the location of the interruption and to report it.

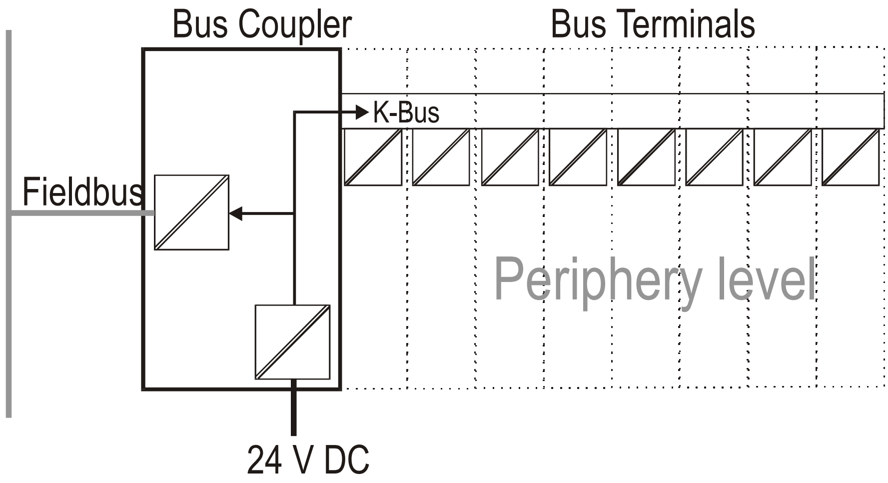
Electrical isolation

BK5200, BK5210:
3 potential groups:
Fieldbus
K-Bus
Peripheral level

The Bus Couplers operate by means of three independent potential groups. The supply voltage feeds the K-Bus electronics in the Bus Coupler and the K-Bus itself, which are electrically separate. The supply voltage is also used to generate the operating voltage for the fieldbus.

Remark: All the Bus Terminals are electrically isolated from the K-Bus. The K-Bus is thus electrically isolated from everything else.

BK5200, BK5210:
Structure of the potential levels in the Bus Terminal system



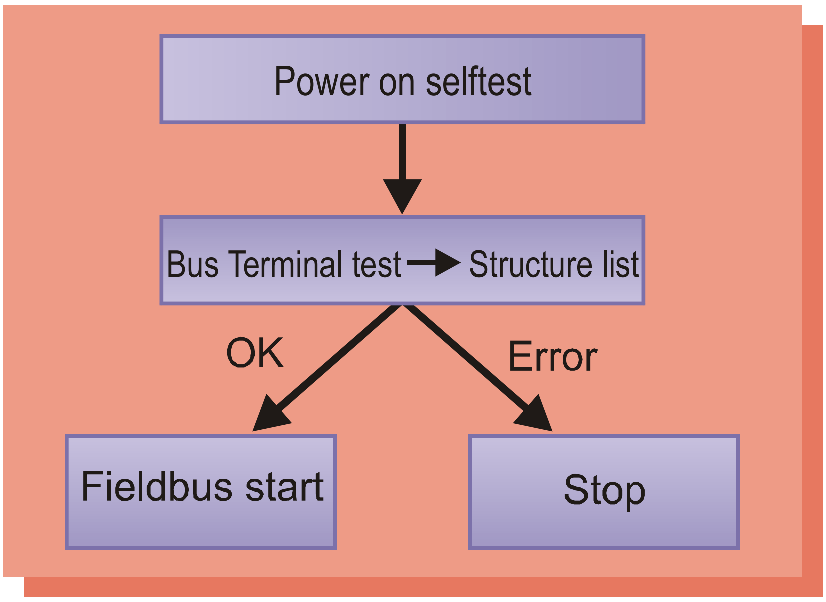
LC5200:

The LC5200 does not provide electrical isolation from the fieldbus and peripheral level. If the peripheral level nevertheless needs to have an electrically isolated implementation, this can easily be achieved through the use of isolating terminals (KL9xxx).

Operating modes of the Bus Coupler

Immediately after being switched on, the Bus Coupler checks, in the course of a “self test”, all the functions of its components and the communication on the K-Bus. The red I/O LED blinks while this is happening After completion of the self-test, the Bus Coupler starts to test the attached Bus Terminals (the ”Bus Terminal Test”), and reads in the configuration. The Bus Terminal configuration is used to generate an internal structure list, which is not accessible from outside. In case of an error, the Bus Coupler enters the “STOP“ state. Once the start-up has completed without error, the Bus Coupler enters the "fieldbus start" state.

Start-up behaviour of the Bus Coupler

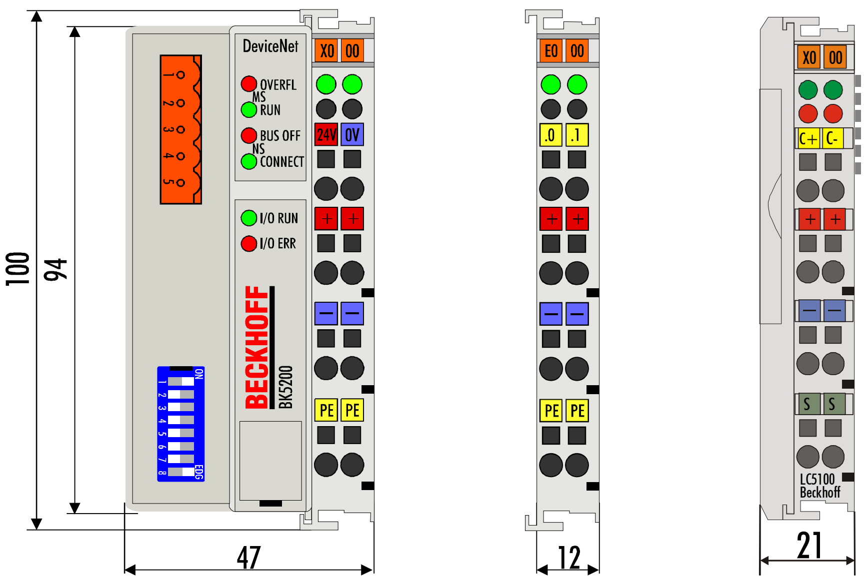


The Bus Coupler reports the error to the master by means of the status byte in the DeviceNet diagnostics (see section "Data exchange"). Clearing the error returns the Bus Coupler to its normal operating mode.

Mechanical construction

The system of the Beckhoff Bus Terminals is characterised by low physical volume and high modularity. When planning a project it must be assumed that at least one Bus Coupler and a number of Bus Terminals will be used. The mechanical dimensions of the Bus Couplers are independent of the fieldbus system.

Bus Coupler dimensions



The total width in practical cases is composed of the width of the Bus Coupler with the bus end terminal and the width of the Bus Terminals in use. Depending on function, the Bus Terminals are 12 or 24 mm wide. The front wiring increases the total height of 68 mm by about 5 to 10 mm, depending on the wire thickness.

Assembly and connection

The Bus Coupler and all the Bus Terminals can be clipped, with a light press, onto a 35 mm C-mounting rail. A locking mechanism prevents the individual housings from being pulled off again. For removal from the mounting rail the orange coloured tension strap releases the latching mechanism, allowing the housing to be pulled off the rail without any force. Work should only be carried out on the Bus Terminals and the Bus Coupler when switched off. Pulling out and inserting under power can cause undefined states to be temporarily caused. (A reset of the Bus Coupler, for example.)

Up to 64 Bus Terminals can be attached to the Bus Coupler on the right hand side. When plugging the components together, be sure to assemble the housings with groove and tongue against each other. A properly working connection can not be made by pushing the housings together on the mounting rail. When correctly assembled, no significant gap can be seen between the attached housings.

The right hand part of the Bus Coupler can be compared to a Bus Terminal. Eight connections on the top permit connection with solid or fine wires. The connection is implemented with the aid of a spring device. The spring-loaded terminal is opened with a screwdriver or rod, by exerting gentle pressure in the opening above the terminal. The wire can be inserted into the terminal without any force. The terminal closes automatically when the pressure is released, holding the wire securely and permanently.

The connection between the Bus Coupler and the Bus Terminals is automatically realised by pushing the components together. The transfer of the data and the supply voltage for the intelligent electronics in the Bus Terminals is performed by the K-Bus. The field electronics are supplied in the case of the digital Bus Terminals through the power contacts. Plugging together the power contacts creates a supply rail. Note the circuit diagrams for the Bus Terminals, since some Bus Terminals do not loop these power contacts through, or only do so partially (e.g. analog Bus Terminals or 4 channel digital Bus Terminals). The potential feed terminals interrupt the power contacts, and represent the start of a new supply rail. The Bus Coupler can also be made use of to feed the power contacts.

Insulation testing

The power contact labelled “PE” can be used as a protective earth. For safety reasons this contact mates first when plugging together, and can ground short-circuit currents of up to 125 A. Note that, for reasons of electromagnetic compatibility, the PE contacts are capacitively coupled to the mounting rail. This can both lead to misleading results and to damaging the terminal during insulation testing. (e.g.: breakdown of the insulation from a 230 V power user to the PE conductor.) The PE conductor to the Bus Coupler must be disconnected for the insulation testing. In order to uncouple further feed locations for the purposes of testing, the feed terminals can be pulled at least 10 mm out from the connected group of other terminals. In that case, the PE conductors do not have to be disconnected.

PE power contacts

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

Technical data

Electrical data

The DeviceNet couplers differ in the level of the facilities they offer. The fieldbus-specific electrical data is listed in this section. The following data differs between the Standard, the Economy and the Low-Cost versions (BK5200, BK5210 and LC5200). Compatibility with DeviceNet is ensured in all cases, but the Economy and Low-Cost versions have a restricted number of I/O points. This is why it is not possible to connect anything other than digital inputs and outputs.

System data	DeviceNet (BK5200, BK5210, LC5200)		
Number of I/O modules	64		
Transmission medium	Screened, twisted copper wire with power supply, 5-pin		
Length of the cable	500 m	250 m	100 m
Transmission rate	125 kbaud	250 kbaud	500 kbaud
Operating modes	Bit Strobe, Polling, Cyclic, Change of State (COS)		
Device Net type	Communications adapter		

Technical data	BK5200	BK5210
Number of Bus Terminals	64	
Digital peripheral signals	256 inputs/outputs	256 inputs/outputs
Analog peripheral signals	128 inputs/outputs	---
Possibility of configuration	Via KS2000 or the controller	
Maximum number of bytes	512 bytes input, 512 bytes output	32 bytes input, 32 bytes output
Bus connection	1 x open pluggable connector, 5-pin, included	
Power supply	24 V DC (20...29 V DC), via bus cable 11… 25V (conforms to DeviceNet specification)	
Input current	70 mA + (total K-Bus current)/4 500 mA max.	
Starting current	approx. 2.5 x continuous current	
Recommended back-up fuse	≤ 10 A	
K-Bus power supply up to	1750 mA	500 mA
Power contact voltage	24 V DC max.	
Power contact current load	10 A max.	
Dielectric strength	500 Veff (power contact / supply voltage Bus Coupler)	
Weight approx.	150 g	130 g
Operating temperature	0°C ... +55°C	
Storage temperature	-25°C ... +85°C	
Relative humidity	95% , no condensation	
Vibrations/Shock resistance	conforms to IEC 68-2-6/IEC 68-2-27	
EMC resistance burst/ESD	conforms to EN 50082 (ESD, burst)/EN 50081	
Installation position	any	
Protection class	IP20	

Technical data	LC5200
Number of Bus Terminals	64
Digital peripheral signals	256 inputs/outputs
Analog peripheral signals	
Possibility of configuration	Via KS2000 or the controller
Maximum number of bytes	32 bytes input and 32 bytes output
Bus connection	directly to spring-loaded terminals
Power supply	24 V DC (20...29 V DC), via bus cable 11…25V (conforms to DeviceNet specification)
Input current	70 mA + (total K-Bus current)/4 500 mA max.
Starting current	approx. 2.5 x continuous current
Recommended back-up fuse	≤ 10 A
K-Bus power supply up to	500 mA
Power contact voltage	24 V DC max.
Power contact current load	10 A max.
Electrical isolation	none between power supply/fieldbus/power contacts
Size	similar to the Bus Terminal housing, width 21 mm
Weight approx.	100 g
Operating temperature	0°C ... +55°C
Storage temperature	-25°C ... +85°C
Relative humidity	95% , no condensation
Vibrations/Shock resistance	conforms to IEC 68-2-6/IEC 68-2-27
EMC resistance burst/ESD	conforms to EN 50082 (ESD, burst)/EN 50081
Installation position	any
Protection class	IP20

Peripheral data in the process image

After being switched on, the Bus Coupler determines the configuration of the inserted input/output terminals. The assignment of the physical slots for the input/output channels and the addresses in the process image is carried out automatically by the Bus Coupler.

The Bus Coupler creates an internal assignment list, in which the input/output channels have a specific position in the process image. A distinction is made here according to inputs and outputs, and according to bit-oriented (digital) and byte-oriented (analog or complex) signal processing.

Two groups are created, one for inputs and the other for outputs. Each group has the byte-oriented channels in ascending sequence starting from the lowest address. The bit-oriented channels are placed after this block.

Digital signals (bit-oriented)

The digital signals are bit-oriented. This means that one bit in the process image is assigned to each channel. The Bus Coupler creates a memory area containing the current input bits, and ensures that the bits in a second memory area dedicated to the output channels are written out immediately.

The details of the assignment of the input and output channels to the controller's process image is explained fully with the aid of an example in the appendix.

Analog signals (byte-oriented)

The processing of analog signals is always byte-oriented. Analog input and output values are represented in memory by two bytes each. Values are represented in SIGNED INTEGER or two‘s complement format. The number "0" stands for the input/output value "0 V", "0 mA" or "4 mA". The maximum value of an output or input value is represented, according to the standard settings, by "7FFF" (hex). Negative input or output values, e.g. -10 V, are represented from "1000" (hex). The intermediate values are correspondingly proportional. A range with a resolution of 15 bits is not achieved for all inputs and outputs. If the actual resolution is 12 bits, the last three bits have no effect in outputs, while as inputs they are read as "0". Each channel also has a control and status byte. The control and status byte is the highest value byte. Version 2.0 of the DeviceNet coupler does not permit the control and status byte to be read. An analog channel is represented in the process image by 2 bytes. The following versions permit expansion of a channel's data width by means of the KS2000 configuration software.

Special signals and interfaces

A Bus Coupler supports Bus Terminals with other interfaces such as RS232, RS485, incremental encoder and others. These signals can be considered similarly to the analog signals named above. For some special signals the bit width of 16 is not sufficient. The Bus Coupler can support any byte width.

Default assignment of inputs/outputs to the process image

Once it has been switched on, the Bus Coupler finds out how many Bus Terminals are inserted, and creates an assignment list. The analog and digital channels, divided into inputs and outputs, are assembled into separate parts of this list. The assignment starts on the left next to the Bus Coupler. The software in the Bus Coupler collects the individual entries for each of the channels in order to create the assignment list counting from left to right.

Four groups are distinguished in the assignment:

	Functional type of the channel	Assignment level
1.	Analog outputs	assignment by bytes
2.	Digital outputs	assignment by bits
3.	Analog inputs	assignment by bytes
4	Digital inputs	assignment by bits

Complex multi-byte signal Bus Terminals are represented as analog inputs or outputs.

The distribution of the process image in the Bus Coupler in overview:

Output data in the Bus Coupler

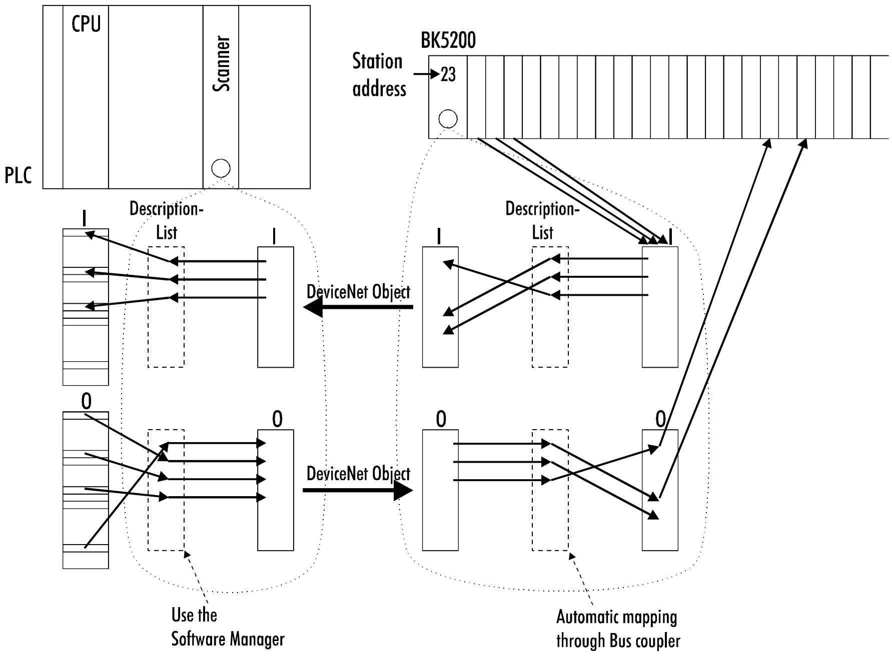
O0 ... ... Ox	byte-oriented data
Ox+1 Ox+y	bit-oriented data

Input data in the Bus Coupler

I0 Ix	byte-oriented data
Ix+1 ... ... Ix+y	bit-oriented data

The path from the I/Os to the DeviceNet process image

I/O Lists in the BK5200 DeviceNet and the PLC (Scanner)



Data consistency

Data whose content is all correctly associated is said to be consistent. Examples of data items that belong together are: 1. the high and low bytes of an analog value (word consistency), and 2. a control/status byte and the associated parameter word for access to the registers. Data consistency in the interaction of peripheral devices and their controllers is, in a basic sense, only assured for a single byte. In other words, the bits of a byte are written or read together. Byte consistency is sufficient for handling digital signals. Whenever values have a length of more than 8 bits, analog values for instance, the consistency must be extended. The different bus systems guarantee consistency up to the required length. Correct transfer of the consistent data from the bus system master to the controller is important. The corresponding manual for the bus system will provide a detailed description of the correct procedure, in particular the description of the master interfaces used. Those chapters of this manual that deal with the fieldbus refer to the most widespread interfaces.

Complex signal processing

All the byte-oriented signal channels such as RS232, RS485 or incremental encoders operate to some extent with byte lengths of more than two. Apart from the difference in length, they are always handled similarly to the analog signals.

Start-up procedure and Diagnostics

After switching on, the Bus Coupler immediately checks the connected 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. There is a detailed description in the section on "The diagnostic LEDs".

The diagnostic LEDs

The Bus Coupler has two groups of LEDs for the display of status. The upper group with four LEDs indicates the status of the respective fieldbus. The significance of the “fieldbus status“ LED is explained in the relevant sections of this manual - it conforms to conventional fieldbus displays.

On the upper right hand side of the Bus Couplers are two more green LEDs that indicate the supply voltage. The left hand LED indicates the presence of the 24 V supply for the Bus Coupler. The right hand LED indicates the presence of the supply to the power contacts.

Local errors

Two LEDs, the “I/O LEDs”, in the area below the field bus status LEDs referred to above, serve to indicate the operating status of the Bus Terminals and the connections to these terminals. The green LED lights up in order to indicate fault-free operation. The red LED blinks with two different frequencies in order to indicate an error. The error is encoded in the blinks as follows:

Blink code

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

Error location

Error code	Error code argument	Description
1 pulse	0 1 2	EEPROM checksum error Inline code buffer overflow Unknown data type
2 pulses	 0 n (n > 0)	Programmed configuration Incorrect table entry / Bus Coupler Incorrect table comparison (terminal n)
3 pulses	0	Terminal bus command error
4 pulses	0 n	Terminal bus data error Break behind terminal n (0: Coupler)
5 pulses	n	Terminal bus error in register communication with terminal n
6 pulses	0 n (n > 0)	Special fieldbus error

The number of pulses in the first sequence indicates the error type, while the second sequence 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 Bus Coupler to leave the blink sequence. The Bus Coupler stays in the "Stop" state. The Bus Coupler can only be re-started either by switching the power supply off and on again, or by a scanner reset.

Insertion and removal of Bus Terminals is only permitted when switched off. The electronics in the Bus Terminals and in the Bus Coupler are protected to a large measure against damage, but incorrect function and damage cannot be ruled out if they are plugged in under power.

The occurrence of a fault in the course of operation does not immediately trigger the display of error codes by the LEDs. The Bus Coupler must be requested to diagnose the Bus Terminals. The diagnostic request is generated at power-up or through an access by the fieldbus to the Bus Coupler. This means that if no data is being exchanged over DeviceNet when a bus terminal is removed from the system, the Bus Coupler will not necessarily report an error.

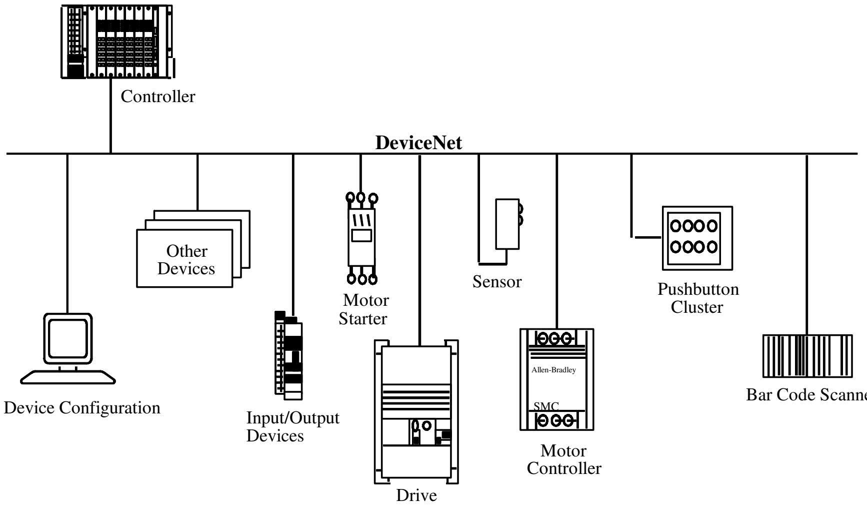
BK5200, BK5210, LC5200 DeviceNet

Introduction to the system

DeviceNet
BK5200, BK5210:
Bus power and terminal power are supplied separately.
Both power supplies must be connected.

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 of 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 devices which conform to the specification can operate together in one system, regardless of their manufacturer.



Examples of DeviceNet in use

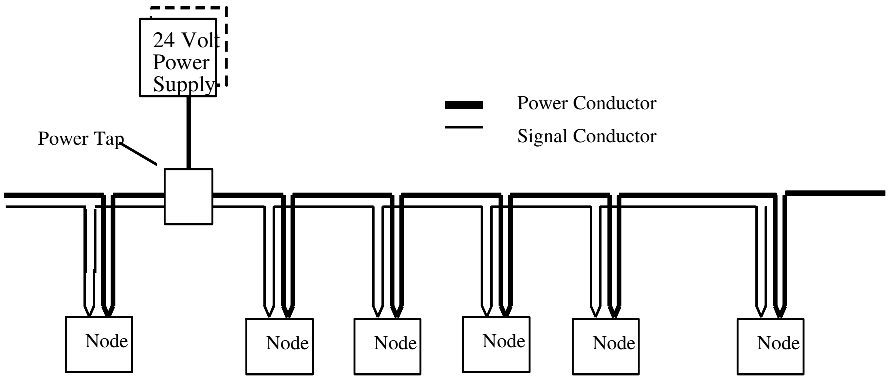
CAN's bit arbitration procedure makes it theoretically possible to operate communication networks using master/slave and multimaster access methods. The BK5200 Bus Coupler with the corresponding software release B2 supports master/slave operation (in polling mode), with the Bus Coupler functioning as slave. Subsequent releases of the Bus Coupler software will also support multimaster operation.

The BK5200 and BK5210 Bus Couplers are not supplied with power via the DeviceNet bus cable. The Bus Coupler and the peripherals (the Bus Terminals) must be wired up using the connections on the top right-hand side (this is explained in the introductory pages). This enables you to isolate the bus electrically from the peripherals. If you wish, you can connect the power supply of the bus cable to the peripheral side and dispense with the decentralised power supply.

The LC5200 Bus Coupler is supplied with power via the DeviceNet bus cable. This means that there is no electrical isolation between the bus and the peripherals. If the peripheral level nevertheless needs to have an electrically isolated implementation, this can easily be achieved through the use of isolating terminals (KL9xxx).

Bus cable

The bus cable consists of two pairs of shielded twisted-pair wires, one for the data transfer and one for the power supply. The latter can carry currents of up to 8 amperes. The maximum possible length of a line depends essentially on the baud rate. If you choose the highest Baud rate (500 kbaud) you are restricted to lines of at most 100 m. With the lowest Baud rate (125 kbaud) you will be able to use cable with an overall length of 500 m.



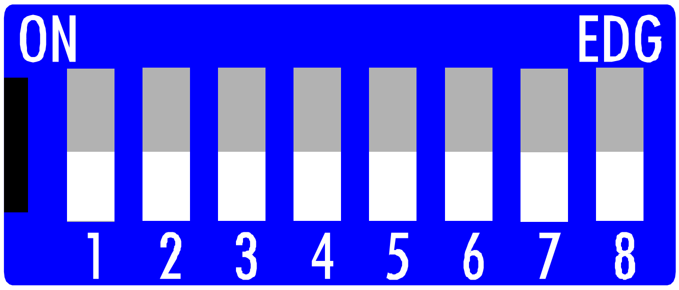
The bus cable may consist of a main line with branch lines up to 6m long. It is important that both ends of the main line should carry 121 Ω terminating resistors. You can operate up to 64 devices on one line. If you want to be able to plug and unplug Bus Couplers while the equipment is in operation you should attach the terminating resistors permanently to the bus cable.

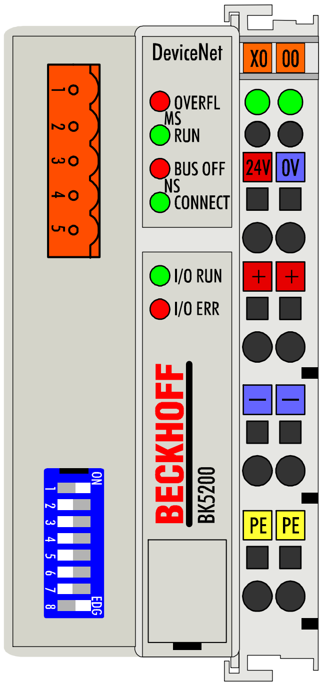
Parameterisation

Special DeviceNet configuration software should be used to parameterise the system. The user places the parameterisation data in the master with this software. When it is first switched on, the master will compare its stored settings with the actual configurations of each of the stations. The exchange of user data between master and slave will not be initiated unless all the parameters agree. Setting the parameters for the master is carried out directly via the DeviceNet connection. The DeviceNet system does not use a separate interface such is provided for other fieldbusses.

Configuring the Bus Coupler

Set all the DIP switches to the desired configuration before you switch on the Bus Coupler. Switches 7 and 8 are used to set the baud rate, as shown in the following table.





Setting the DIP switches

Setting the baud rate

Setting baud rates	1	2	3	4	5	6	7	8
125 kbaud							**off**	**off**
250 kbaud							**on**	**off**
500 kbaud							**off**	**on**
(Default) 125 kbaud							**on**	**on**

Setting the MAC ID

DIP switches 1 to 6 are used to set the MAC ID, where switch 1 is the lowest value bit 20, and switch 6 the highest value bit 25. The bit is set when the switch is ON.

You can select the MAC ID from the range 0 to 63.

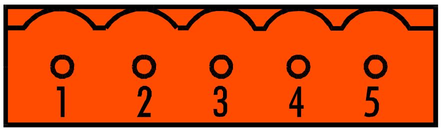
Switch on the Bus Coupler

When you have set all the DIP switches to the desired configuration you can switch on the Bus Coupler. Any changes you make to the switches while the system is in operation will have no effect until the next time it is switched on.

Connector Pin assignment / DeviceNet connection

DeviceNet connection BK5200, BK5210:
Bus power and terminal power are supplied separately.
Both power supplies must be connected.

A 5-pin plug is supplied to connect the DeviceNet bus cable. When it is plugged into the Bus Coupler, pin 1 is at the top. The figure shows the socket in the Bus Coupler. The power supplied by this plug is isolated from the power supply of the terminal to the right of the Bus Coupler. Both power sources must be connected before the system can operate.

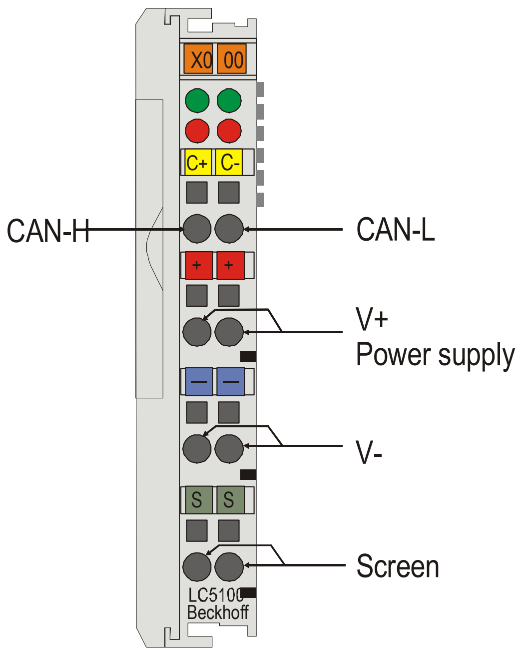


Pin assignment of DeviceNet connection	
1	V+
2	CAN-H
3	GND
4	CAN-L
5	V-

DeviceNet connection LC5200

In the low cost LC5200 coupler, the CAN wires are connected directly to the contact points 1 (CAN-H, marked with C+) and 5 (CAN-L, marked with C-). V+ is placed on the terminal locations 2 and 6. V- is placed on the terminal locations 3 and 7. The screen can optionally be connected to contact points 4 or 8, which are connected to the top hat rail via an R-C network.

Connection diagram for the LC5200 Bus Coupler



Data exchange

Data string from the DeviceNet master to the Bus Coupler: first byte-oriented data, and then bit-oriented data.

Data is transferred between masters and slaves in the form of objects. The Bus Coupler recognises two objects: an input object and an output object. You can use the configuration software to map the input/output bytes onto specific memory areas in the controller. The Bus Coupler uses a consistent algorithm to correlate the object data to the peripherals. Various examples of correlations between addresses and peripherals are explained in the appendix. A (data) object which is transferred from the DeviceNet master to the Bus Coupler must begin with the byte-oriented values, which is the data for the analog output terminals. The bit-oriented data for digital outputs may not be transmitted until all the byte-oriented values have been sent.

4 bytes for 2-channel analog output terminals 2 bits for 2-channel digital output terminals

Analog outputs receive 16 bits of data, i.e. two bytes, for each channel. An analog output terminal with 2 channels must therefore receive 4 bytes. A digital output terminal with 2 channels needs a total of 2 bits of data, one for each channel.

First the data from all the analog outputs

The first 4 bytes of an object which is transferred to the terminal strip are assigned to the first analog output terminal, which is the analog output terminal nearest to the Bus Coupler. Other terminals which are located between the Bus Coupler and the first analog output terminals are disregarded. The next four bytes of the object go to the second analog output terminal in the terminal strip. Any other terminals between the first and second analog output terminals are disregarded.

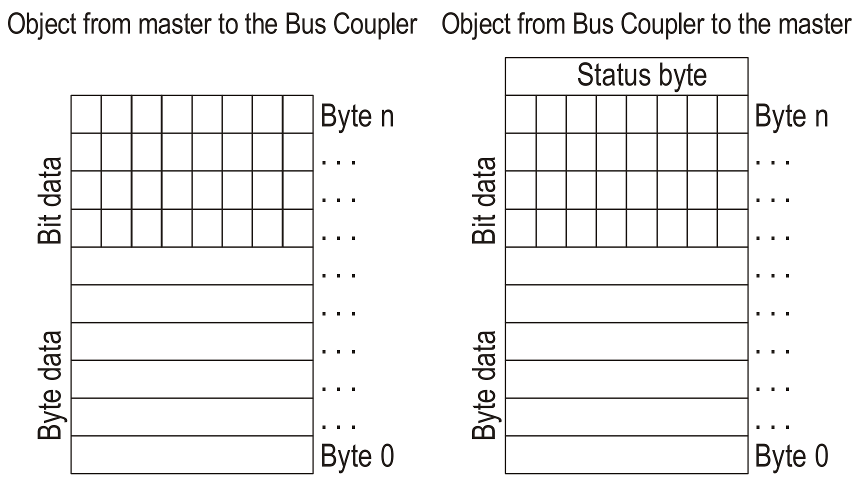
Then the data for the digital outputs is transmitted in bytes

When the last analog output terminal in the terminal strip has received its data, the digital outputs are served. Data is always transferred in the form of bytes, so the next byte from the data string contains data for 8 digital outputs. Bit 0 and bit 1 are assigned to channels 1 and 2 of the first digital output terminal after the Bus Coupler. Other types of terminal which are located in between are ignored.

Bits 2 and 3 go to the 2 channels of the second digital output terminal, bits 4 and 5 to the third and bits 6 and 7 to the fourth. There may be other terminals located between these digital output terminals, and if so they will be disregarded.

Some of the bits in the last byte may be unused

Additional bytes are read from the data string until the last digital output in the terminal strip has been dealt with. If the total number of digital outputs is not a multiple of 8, there will be a number of bits left over in the last data byte; these will be discarded.



Object from the Bus Coupler to the DeviceNet master for transferring the input data:

The object sent by the Bus Coupler to the DeviceNet master also contains the byte-oriented data at the beginning, followed by the bit-oriented data. Transfers in this direction also include a status byte, which comes right at the end of the object.

The byte-oriented data contains the values from the analog inputs and the bit-oriented data the values from the digital inputs.

first byte-oriented data,

The first four bytes contain the data from the first analog input terminal in the terminal strip, where each pair of bytes is the 16 bit value of one input. The next four bytes correspond to the next analog input terminal and so on, analogously to the procedure described above.

and then bit-oriented data.

After the byte-oriented data from all the analog inputs come the values from the digital inputs. Eight digital inputs are transferred in each byte. As before, if the total number of digital inputs in the terminal strip is not a multiple of 8, the last data byte will contain one or more superfluous bits.

Status byte at the end of the object sent to the master

Status byte=0: I/O RUN
Status byte=1: I/O ERR

An extra status byte is transferred at the end of each string sent by the Bus Coupler to the DeviceNet master, and this returns the status of the terminal strip. Its value corresponds to the status displayed on the I/O LEDs on the Bus Coupler: while the terminal strip is functioning correctly, the LED ”I/O RUN” will be lit and the status byte will contain the value 0; as soon as an error occurs, the LED ”I/O ERR” will light up and the status byte will contain the value 1.

Light-emitting diodes

	Module status LEDs ”MS”	
LED "RUN"	The green LED flashes:	Configuration is incorrect
	The green LED is permanently lit:	Status is OK.
LED "OVERFL"	The red LED flashes:	Receive queue overflow
	The red LED is permanently lit:	Status is OK.
	Network status LEDs ”NS”	
LED "CONNECT"	The green LED flashes:	Bus Coupler is ready for communication, but not yet assigned to the master.
LED "BUS OFF"	The green LED is permanently lit:	Bus Coupler is assigned to the master, data is being exchanged.
	The red LED flashes:	Timeout on I/O connection
	The red LED is permanently lit:	BUS OFF: CAN error, devices have identical node addresses.
	Input/output status ”I/O”	
LED "I/O RUN"	The green LED is lit:	The Bus Terminals are working correctly.
LED "I/O ERR"	The red LED is lit:	I/O error, a Bus Terminal or an internal K-Bus with a fault.
LED "I/O ERR"	The red LED flashes:	The Bus Terminals are being configured

Vendor ID

The vendor ID is # 108.

DeviceNet Group

The BK5200, BK5210 and LC5200 Bus Couplers are exclusively Group 2 devices.

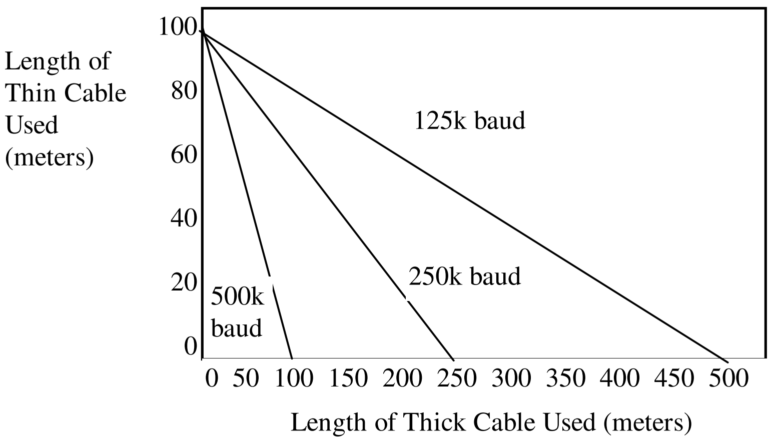
IDENTIFIER BITS											MESSAGE ID MEANING
10	9	8	7	6	5	4	3	2	1	0	
1	0	MAC ID						Group 2 Message ID			Group 2 Messages
1	0	MAC ID						0	0	0	Group 2 Message Identifier
1	0	MAC ID						0	0	1	
1	0	MAC ID						0	1	0	
1	0	MAC ID						0	1	1	
1	0	MAC ID						1	0	0	
1	0	MAC ID						1	0	1	
1	0	Destination MAC ID						1	1	0	Reserved for Predefined Master/Slave Connection Management
1	0	Destination MAC ID						1	1	1	Duplicate MAC ID Check Message

Overview of the identifiers used

Bus cable: length, assignment

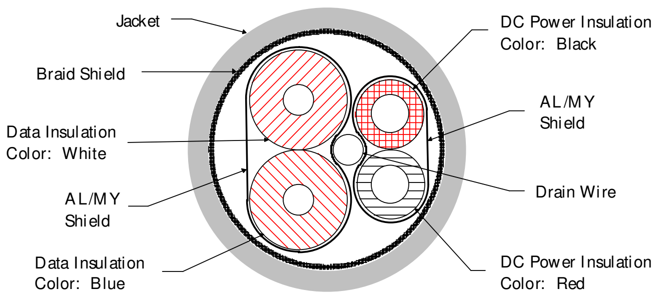
The maximum length of cable which can be used depends on the selected baud rate. The following lengths should be understood as the total length of the main line plus any branch lines.

125 kbaud	500 m
250 kbaud	250 m
500 kbaud	100 m

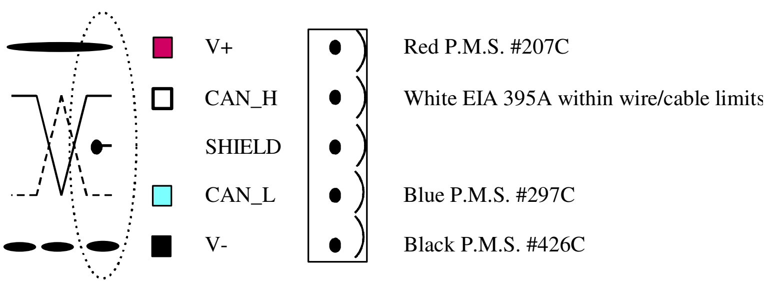


$L_{thick} + 5 \times L_{thin} = 500$ at 125Kbaud
$L_{thick} + 2.5 \times L_{thin} = 250$ at 250Kbaud
$L_{thick} + L_{thin} = 100$ at 500Kbaud

where L_{thick} is the length of thick cable and Lthin is the length of thin cable.



The cable consists of two shielded wire pairs. One pair carries out the transmission. The second pair distributes the supply power.

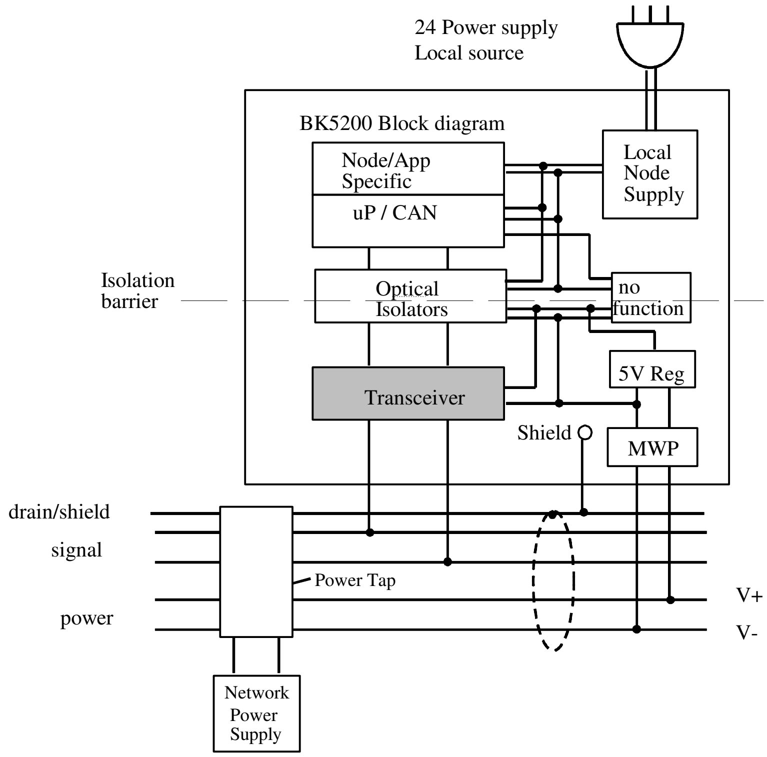


Connector wiring information

Electrical isolation

BK5200, BK5210

The Bus Coupler BK5200 have electrical isolation between the DeviceNet bus cable and the communication electronics of the Bus Coupler.



Potential levels of the BK5200 and BK5210

LC5200:

The LC5200 does not provide electrical isolation from the fieldbus and peripheral level. If the peripheral level nevertheless needs to have an electrically isolated implementation, this can easily be achieved through the use of isolating terminals (KL9xxx).

Appendix

Example: composition of a process image in the Bus Coupler

An example shows the assignment of in- and output channels to the process image. The sample construction is to consist of the following assembly of Bus Terminals:

With this configuration, the Bus Coupler sets up the following assignment list

Position	Functional groups on the rail
POS01	Bus Coupler
POS02	Digital inputs, 2 channels
POS03	Digital inputs, 2 channels
POS04	Digital inputs, 2 channels
POS05	Digital inputs, 2 channels
POS06	Digital inputs, 2 channels
POS07	Digital outputs, 2 channels
POS08	Digital outputs, 2 channels
POS09	Digital outputs, 2 channels
POS10	Analog inputs, 2 channels
POS11	Analog outputs, 2 channels
POS12	Analog outputs, 2 channels
POS13	Analog inputs, 2 channels
POS14	Power feed terminal
POS15	Digital inputs, 2 channels
POS16	Digital inputs, 2 channels
POS17	Digital inputs, 2 channels
POS18	Digital outputs, 2 channels
POS19	Digital outputs, 2 channels
POS20	Analog outputs, 2 channels
POS21	End terminal

By default, DeviceNet only supports signal channels that are 16 bits wide. The STATUS/CONTROL BYTE is not available. This means, for instance, that an analog input terminal with 2 channels appears with 2 x 16 bits in the process image. The images have corresponding differences with respect to byte addresses and assignments.

Area for byte-oriented data, analog outputs

Relative byte address	Bit position	Controller process image	Position in the block
0, 1	none	O0, O1	POS11
2, 3	none	O2, O3	POS11
4, 5	none	O4, O5	POS12
6, 7,	none	O6, O7	POS12
8, 9	none	O8, O9	POS20
10, 11	none	O10, O11	POS20

Area for bit-oriented data, digital outputs

Relative byte address	Bit position	Controller process image	Position in the block
12	0	O12	POS07
12	1	O12	POS07
12	2	O12	POS08
12	3	O12	POS08
12	4	O12	POS09
12	5	O12	POS09
12	6	O12	POS18
12	7	O12	POS18
13	0	O13	POS19
13	1	O13	POS19

Area for byte-oriented data, analog inputs

Relative byte address	Bit position	Controller process image	Position in the block
0, 1	none	I0, I1	POS10
2, 3	none	I2, I3	POS10
4,5	none	I4, I5	POS13
5,7	none	I6, I7	POS13

Area for bit-oriented data, digital inputs

Relative byte address	Bit position	Controller process image	Position in the block
4	0	I4	POS01
4	1	I4	POS01
4	2	I4	POS02
4	3	I4	POS02
4	4	I4	POS03
4	5	I4	POS03
4	6	I4	POS04
4	7	I4	POS04
5	0	I5	POS05
5	1	I5	POS05
5	2	I5	POS06
5	3	I5	POS06
5	4	I5	POS15
5	5	I5	POS15
5	6	I5	POS16
5	7	I5	POS16
6	0	I6	POS17
6	1	I6	POS17

Positions POS14 and POS21 are not relevant to data exchange. They do not appear in the list. If a byte is not fully utilised, e.g. E8, the Bus Coupler pads the remaining bits of the byte with zeros.

The distribution of the process image in the Bus Coupler in overview:

Output data in the Bus Coupler

O0 ... ... A11	byte-oriented data
O12 O13	bit-oriented data

Input data in the Bus Coupler

I0 ... ... E3	byte-oriented data
I4 ... ... I6	bit-oriented data

The base addresses I0 and O0 listed here are used as relative addresses or addresses in the Bus Coupler. If you have an appropriate superordinate DeviceNet system, you can use the bus master to enter these addresses at any desired position in the controller's process image. You can use the configuration software of the master to assign the bytes to the addresses in the process image of the controller.

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