BK52XX

Technical Documentation
DeviceNet coupler

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Table of contents

1 Basic information

1.1 The TRS bus terminal system

The bus terminal system is the universal connecting link between a fieldbus system and the sensor/actor level. A unit consists of a bus coupler, which is the interface to the fieldbus, and up to 64 electronic terminals, of which the last is an end terminal. Terminals, each with two I/O channels, are available for any form of technical signal and can be combined as desired. The various types of terminal are all constructed in the same way, so that the planning costs are kept extremely low. The height and depth of the construction are calculated for compact terminal cabinets.

Up to 64 bus terminals

each with 2 I/O channels for any form of signal

Fieldbus technology makes it possible to use compact control architectures. The I/O level does not need to be taken right up to the control unit. Sensors and actors can be connected decentrally with minimal lengths of cable. You can position the control unit at any convenient location in the installation. Using an industrial PC as control unit makes it possible to implement the operating and monitoring element as part of the control hardware, so the control unit can be located on an operating desk, control point or similar. The bus terminals constitute the decentralized input/output level of the control unit in the switch cabinet and its subordinate terminal cabinets. As well as the sensor/actor level, the power unit of the equipment is also controlled via the bus system. The bus terminal replaces a conventional terminal as the cabling level in the switch cabinet; the switch cabinet can be made smaller.

Decentralized wiring of the I/O level

IPC as control unit

Bus couplers for all current bus systems

The TRS busterminal system combines the advantages of a bus system with the functionality of compact terminals. Bus terminals can be used on all current bus systems and serve to reduce the diversity of parts in the control unit, while behaving like the conventional standard units for the relevant bus system and supporting the entire range of functionality of the bus system.

Standard C rail assembly

The simple and compact assembly on a standard C rail, and the direct cabling of actors and sensors without cross connections between the terminals, serve to standardize the installation, as does the uniformly designed labeling.

The small size and great flexibility of the bus terminal system mean that you can use it anywhere that you could use a terminal and use any type of connection – analog, digital, serial or direct sensors.

Modularity

The modular construction of the terminal row, using bus terminals with various functions, limits the number of unused channels to at most one per function. Two channels to a terminal is the optimum solution for the number of unused channels and the cost per channel. The possibility of using power input terminals to provide separate power supplies also helps to minimize the number of unused channels.

Display of channel status

The integrated light-emitting diodes close to the sensor/actor indicate the status of each channel.

The K-bus

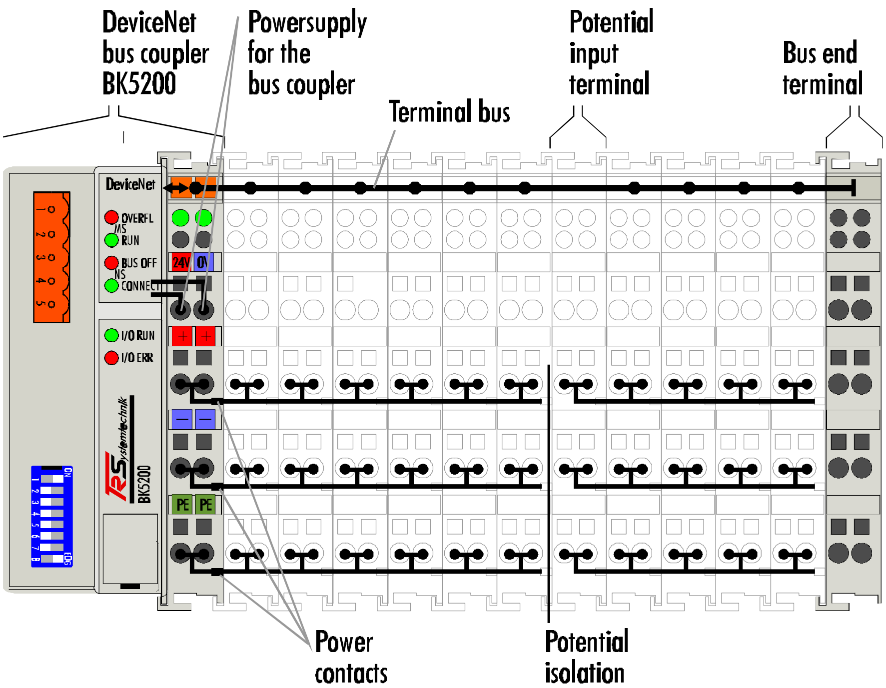
End terminal

The K-bus is the path taken by data within the terminal row. The bus coupler carries the K-bus through all the terminals by means of six contacts on the side walls of the terminals, and the end terminal terminates the K-bus. The user does not need to know anything about the function of the K-bus or the internal operation of terminals and bus couplers. There are numerous software tools available which provide for convenient planning, configuration and operation.

Power input terminals for separately powered groups

Three power contacts pass the operating power to the following terminals. You can use power input terminals to subdivide the terminal row as desired into groups, each with a separate power supply. These power input terminals are not taken into account for addressing the terminals, you can insert them at any position along the terminal row.
You can install up to 64 terminals on a terminal row, including power input terminals and the end terminal.

The principle of the bus terminal



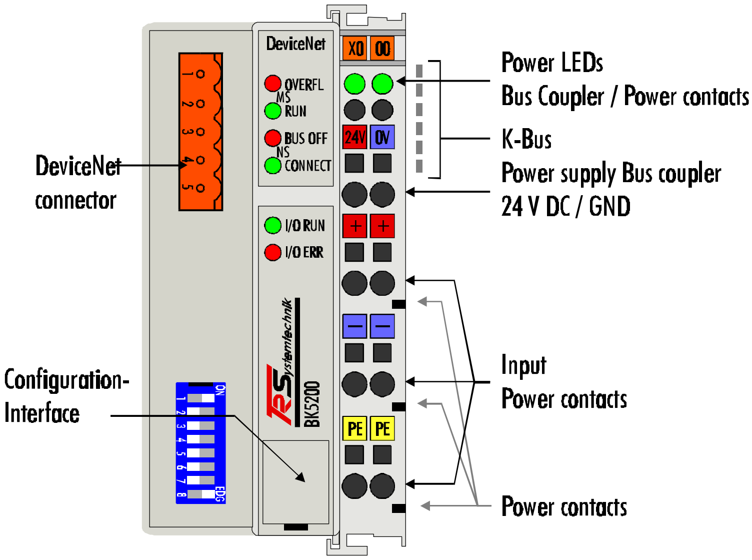
Bus couplers for various fieldbus systems

You can use a variety of bus couplers to attach the electronic terminal row quickly and easily to the various fieldbus systems, and you can also subsequently convert to a different fieldbus system. The bus coupler deals with all the necessary monitoring and control tasks for operating the attached bus terminals, indeed all the operation and configuration of the bus terminals is carried out via the bus coupler. The fieldbus, K-bus and I/O level are electrically isolated.
If the exchange of data across the fieldbus is temporarily interrupted, logic states are preserved, digital outputs are cleared and analog outputs revert to a reset value which can be individually configured for each output when the equipment is set up.

1.2 The interfaces

There are six ways of making a connection to a bus coupler. These interfaces are designed as plug connections and spring terminals.

The DeviceNet coupler BK5200



Power supply

24 V DC on the topmost terminals "24 V" and "0 V"

The bus couplers need an operating power of 24 V DC which is connected via the topmost spring terminals, labeled "24 V" and "0 V". This power supply serves not only the electronic components of the bus coupler but (via the K-bus) also the bus terminals. The power supply of the bus coupler circuitry and that of the K-bus are electrically isolated from the voltage of the field level.

Power supply to the power contacts

Lower 3 terminal pairs for power input

maximum 24 V

maximum 10 A

The six lower connections with spring terminals can be used to supply power to the peripherals. The spring terminals are connected in pairs to the power contacts. The power supply to the power contacts has no connection to the power supply of the bus couplers. The power input is designed to permit voltages up to 24 V. The pair-wise arrangement and the electrical connection between the feed terminal contacts makes it possible to loop through the wires connecting to different terminal points. The load on the power contact may not continuously exceed 10 A. The current capacity between two spring terminals is the same as the capacity of the connecting wires.

Power contacts

Spring contacts at the side

On the right-hand side face of the bus coupler are three spring contacts which are the power connections. The spring contacts are recessed in slots to prevent them from being touched. When a bus terminal is connected, the blade contacts on the left-hand side of the bus terminal are connected to the spring contacts. The slot and key guides at the top and bottom of the bus couplers and bus terminals ensure reliable location of the power contacts.

Fieldbus connection

9-pin Sub-D female connector

On the left-hand side there is a flat recessed area where you can plug in the typical Profibus male connectors. You will find a detailed description of the fieldbus interfaces in another part of this manual (In the chapter “The transfer medium: plugs and cables“).

Configuration interface

Serial interface under the front flap

On the lower part of the front face you will find the standbus couplers which are fitted with an RS232 interface. The miniature plug can be attached to a PC by means of a connection cable and the configuration software BS2000. This interface enables you to configure the analog channels. You can also access the functionality of the configuration interface via the fieldbus by means of the ADS communications.

K-bus contacts

6 contacts at the side

The connections between the bus coupler and the bus terminals are effected by gold contacts at the right-hand side of the bus coupler. When the bus terminals are plugged together, these gold contacts automatically complete the connection to the bus terminals. The K-bus is responsible for the power supply to the electronic components of the K-bus in the bus terminals, and for the exchange of data between the bus coupler and the bus terminals. Part of the data exchange takes place via a ring structure within the K-bus. Disengaging the K-bus, for example by pulling on one the bus terminals, will break this circuit so that data can no longer be exchanged. However, there are mechanisms in place which enable the bus coupler to locate the interruption and report it.

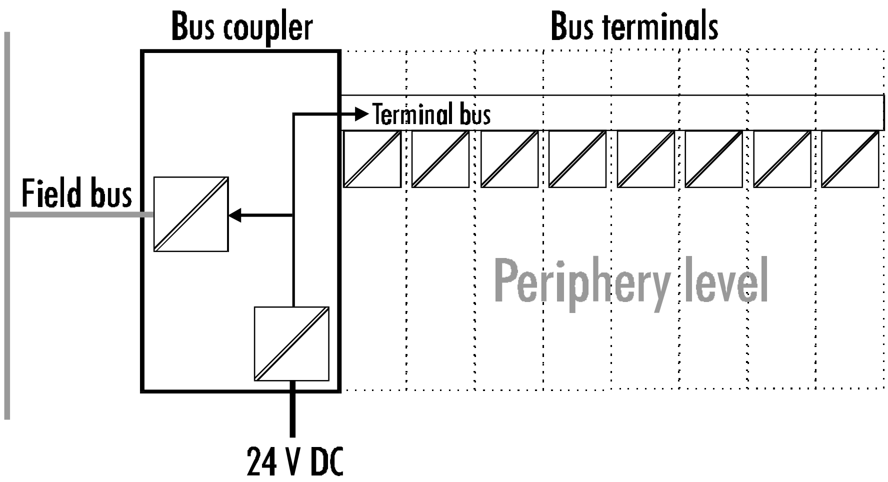
Supply isolation

3 supply groups:
fieldbus
K-bus
peripheral level

The bus couplers operate with three independent supplies. The input power supplies the electrically isolated K-bus circuitry in the bus coupler and the K-bus itself. The power supply is also used to generate the operating power for the fieldbus.

Note: All the bus terminals are electrically isolated from the K-bus, so that the K-bus is completely electrically isolated.

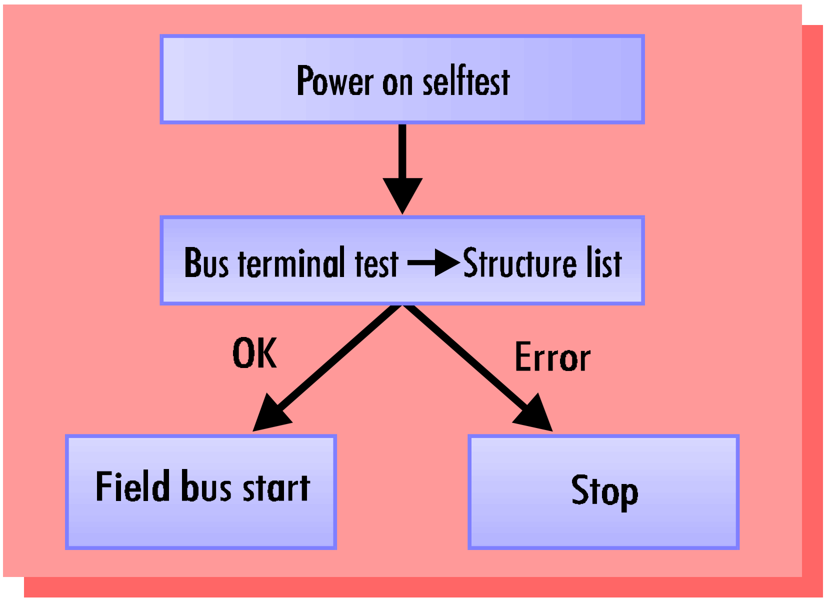
Setting up the power levels in the bus terminal system



1.3 The operating modes of the bus coupler

When it is first switched on the bus coupler carries out a self-test to check the functions of its components and the communications of the K-bus, and while this is going on the red I/O LED will flash. When the self-test has been completed successfully, the bus coupler will begin to test the attached bus terminals (the “bus terminal test“) and read in the configuration from which it constructs an internal structure list, which is not accessible from outside. If an error occurs the bus coupler will enter the operating mode “STOP“. If the start-up sequence is completed without errors the bus coupler will enter the mode “fieldbus start“.

Start-up behavior of the bus coupler

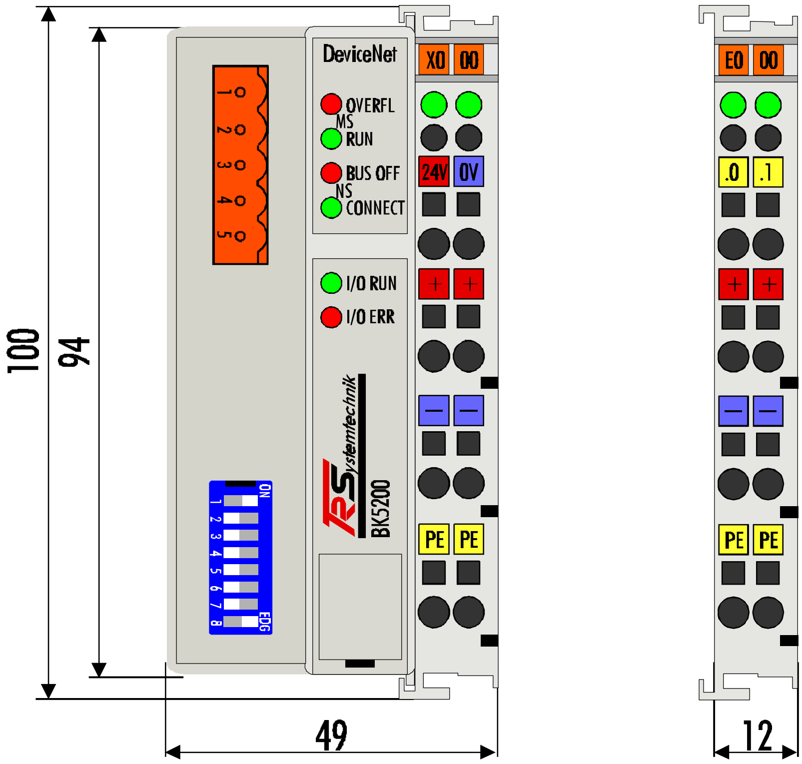


The bus coupler reports the error to the master by means of the DeviceNet diagnostics. Clearing the error returns the bus coupler to its normal operating mode.

1.4 Mechanical construction

The TRS bus terminal system is remarkable for its compact construction and high degree of modularity. When you design the installation you will need to plan for one bus coupler and some number of bus terminals. The dimensions of the bus couplers do not depend on the fieldbus system. If you use large plugs, for example like some of the bus plugs used for the Profibus, they may protrude above the overall height of the cabinet.

Dimensions of a bus coupler



The overall width of the construction is the width of the bus coupler, including the bus end terminal, plus the width of the installed bus terminals. The bus terminals are 12 mm or 24 mm wide, depending on their function. Depending on the gauge of cables used the overall height of 68mm may be overstepped by about 5 mm to 10 mm by the cables at the front.

Assembly and connections

It takes only a slight pressure to latch the bus coupler and the various bus terminals onto a supporting 35mm C rail and a locking mechanism then prevents the individual housings from being removed. You can remove them without effort if you first release the latching mechanism by pulling the orange tab. You should carry out work on the bus terminals and the bus coupler only while they are switched off: if you plug or unplug components while the power is on you may briefly provoke some undefined state (and, for instance, reset the bus coupler).

You can attach up to 64 bus terminals in series on the right-hand side of the bus coupler. When you assemble the components, make sure that you mount the housings so that each slot comes together with the corresponding key. You cannot make any functional connections merely by pushing the housings together along the supporting track. When they are correctly mounted there should be no appreciable gap between the adjacent housings.

The right-hand side of a bus coupler is mechanically similar to a bus terminal. There are eight connections on the top which can be used to connect to thick-wire or thin-wire lines. The connection terminals are spring loaded. You open a spring terminal by applying a slight pressure with a screwdriver or other pointed tool in the opening above the terminal and you can then insert the wire into the terminal without any obstruction. When you release the pressure the terminal will automatically close and hold the wire securely and permanently.

The connection between bus couplers and bus terminals is automatically effected by latching the components together. The K-bus is responsible for passing data and power to the electronic components of the bus terminals. In the case of digital bus terminals, the field logic receives power via the power contacts. Latching the components together has the effect that the series of power contacts constitutes a continuous power track. Please refer to the circuit diagrams of the bus terminals: some bus terminals do not loop these power contacts through, or not completely (e.g. analog bus terminals or 4-channel digital bus terminals). Each power input terminal interrupts the series of power contacts and constitutes the beginning of a new track. The bus coupler can also be used to supply power to the power contacts.

Insulation test

The power contact labeled “PE“ can be used as protective earth or ground. This contactcontacts first for safety reasons and can carry short-circuit currents of up to 125A. Note that in the interests of electromagnetic compatibility the PE contacts are capacitively connected to the supporting track. This may lead to spurious results and even damage to the terminal when you test the insulation (e.g. insulation test for breakdown using a 230V mains supply to the PE line). You should therefore disconnect the PE line on the bus coupler while you carry out insulation tests. You can disconnect other power supply points for the duration of the test by drawing the power supply terminals out from the remaining row of terminals by at least 10mm. If you do this, there will be no need to disconnect the PE connections.

PE power contacts

The protective earth power contact (“PE“) may not be used for any other connections.

Electrical data

DeviceNet couplers may have different configuration levels. The electrical data specific to the fieldbus is listed in the appropriate chapter. The following data distinguishes between the standard version and the economy version (BK5200 and BK5210). Either version is fully compatible to the DeviceNet, but the economy version has only a limited number of I/O points, which is why it permits you to attach only digital inputs and outputs.

Technical data	DeviceNet coupler BK5200	Economy coupler BK5210
Voltage supply	24 V, + / - 10%	
Input current	105 mA typical 900 mA max.	85 mA typical 300 mA max.
Output current K-bus	1.75 A max.	0.5 A max.
Supply isolation	500 Veff (K-bus / supply voltage)	
Number of bus terminals	64	
Digital peripheral signals	256 inputs and outputs	256 inputs and 256 outputs
Analog peripheral signals	122 inputs and outputs #1	--
Peripheral bytes	244 input #1 and 244 output bytes	32 input and 32 output bytes
Configuration interface	Available for KS2000	
Baud rates	Standards-conform, 125, 250 and 500 KBaud	
Voltage power contact	24V DC / AC	
Current load power con.	10 A	
Max. short circuit current	125 A	
Max. voltage capacity	500 Veff (power contact / supply voltage)	
Weight approx.	170g	
Operating temperature	0°C ... +55°C	
Storage temperature	-20°C ... +85°C	
Relative humidity	95% non-condensing	
Vibration /shock resistance	according to IEC 68-2-6 / IEC 68-2-27	
Interference resistance. Burst / ESD	according to EN 61000-4-4 / EN 61000-4-2, limit EN 50082-2-4	
Orientation for mounting	any	
Type of fuse	IP20	

1.5 The peripheral data in the process image

When the bus coupler is first switched on it determines the configuration of the attached input/output terminals and automatically assigns the physical slots of the input/output channels to the addresses in the process image.

The bus coupler sets up an internal list of assignments in which each of the input and output channels has a specific position in the process image. A distinction is made here between input and output and between bit-oriented (digital) and byte-oriented (analog, or complex) signal processing.

It also forms two groups, whereby one contains only inputs and the other only outputs. In each group, the byte-oriented channels take the lowest addresses, in ascending order, and these are then followed by the bit-oriented channels.

Digital signals (bit-oriented)

Digital signals are bit-oriented. This means that one bit of the process image is assigned to each digital channel. The bus coupler sets up a block of memory containing the current input bits and arranges to immediately write out the bits from a second block of memory which belongs to the output channels.

The precise assignment of the input and output channels to the process image of the control unit is explained in detail in the Appendix by means of an example.

Analog signals (byte-oriented)

The processing of analog signals is always byte-oriented and analog input and output values are stored in memory in a two-byte representation. The values are held as "SIGNED INTEGER" or "twos-complement". The digit "0" represents the input/output value "0V", "0mA" or "4mA". When you use the default settings, the maximum value of the input/output value is given by "7FFF" hex. Negative input/output values, such as -10V, are represented as "1000" hex and intermediate values are correspondingly proportional to one another. The full range of 15-bit resolution is not realized at every input/output level. If you have an actual resolution of 12 bits, the remaining three bits have no effect on output and are read as "0" on input. Each channel also possesses a control and status byte in the highest value byte, although version 2.0 of the DeveNet coupler does not permit the control and status byte to be read. An analog channel is represented by 2 bytes in the process image.

Special signals and interface

A bus coupler supports bus terminals with additional interfaces, such as RS232, RS485, incremental encoder, etc.. These signals can be regarded in the same way as the analog signals described above. A 16-bit data width may not be sufficient for all such special signals; the bus coupler can support any data width.

Default assignment of inputs and outputs to the process image

When the bus coupler is first switched on it determines the number of attached bus terminals and sets up a list of assignments. This list distinguishes between analog channels and digital channels and between input and output; which are grouped separately. The assignments begin immediately to the left of the bus coupler. The software in the bus coupler creates the assignment list by collecting the entries for the individual channels one at a time, counting from left to right. These assignments distinguish four groups:

	Function type of the channel	Assignment level
1.	Analog outputs	byte-wise assignment
2.	Digital outputs	bit-wise assignment
3.	Analog inputs	byte-wise assignment
4	Digital inputs	bit-wise assignment

Complex multi-byte signal bus terminals are represented as analog inputs or outputs

Overview of the subdivision of the process image in the bus coupler:

Output data in the bus coupler

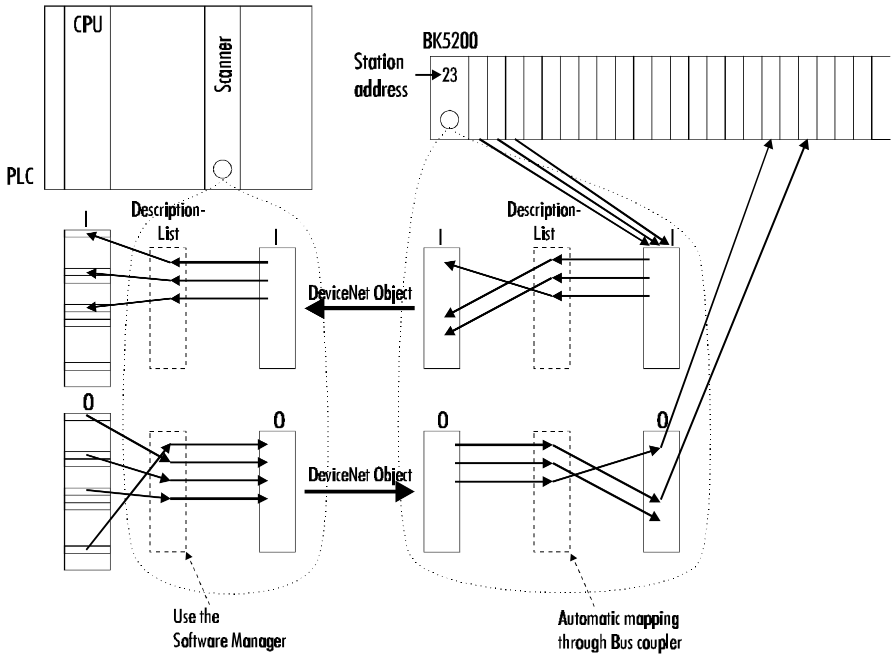
O0 ... ... Ox	byte-oriented data
Ox+1 Ox+y	bit-oriented data

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 which contains no contradictions is said to be consistent. The following consistency is required here: 1. The high byte and low byte of an analog value (word consistency), 2. The control/status byte and the corresponding parameter word for accessing the register. The interaction of the peripherals with the control unit means that data can initially be guaranteed consistent only within an individual byte: the bits which make up a byte are read in together, or written out together. Byte-wise consistency is quite adequate for processing digital signals but is not sufficient for transferring values longer than eight bits, such as analog values. The various bus systems guarantee consistency to the required length. It is important to use the appropriate procedure for importing this consistent data from the master bus system to the control unit. You will find a detailed description of the correct procedure in the User Guide of the appropriate bus system, in particular in the description of the standard master units that are installed. The chapters of this manual which deal with the fieldbus refer to the most common of these standard units.

Processing complex signals

All byte-oriented signal channels such as RS232, RS485 and incremental encoder, can use byte lengths greater than two. Apart from the actual difference in length, the procedure is always comparable with that for analog signals.

1.6 Starting operation and diagnostics

When the bus coupler is first switched on it at once checks the attached configuration. A correct start-up procedure is indicated by the red LED "I/O ERR" going out. If this LED flashes, this indicates a fault somewhere in the terminals. You can determine the actual error code by observing the speed of flashing and number of flashes. This will enable you to clear the fault quickly. You will find a detailed description in the chapter "The diagnostic LEDs".

The diagnostic LEDs

The bus coupler has a status display consisting of two groups of LEDs. The upper group has four LEDs which indicate the mode of the installed fieldbus. The significance of these "fieldbus status LEDs" is explained in the appropriate chapters of this manual; they correspond to the usual displays for fieldbuses.

There are two more green LEDs at the top right-hand side of the bus coupler to indicate the supply voltage. The left-hand LED shows the 24V supply of the bus coupler. The left-hand LED shows the supply to the power contacts.

Local errors

Two LEDs, the "I/O LEDs", which are situated below the fieldbus status LEDs described above, are used to display the operating mode of the bus terminals and the connection to these bus terminals. The green LED lights up to indicate error-free operation, where "error-free" implies that communication with the fieldbus system is also operating correctly. The red LED flashes at two different rates to indicate a fault, whereby the specific error is encoded in the pattern of flashes, as follows.

Code of flashes	Rapid flashing	Start of the error code
	First slow sequence	Type of error
	Second slow sequence	Location of error

Type of error	1 flash	
	2 flashes	
	3 flashes	Connection to the bus terminals cannot be set up correctly
	4 flashes	Break in the K-bus

Location of error

The number of flashes corresponds to the position of the lasK-bus terminal before the error, not counting passive bus terminals such as power input terminals.
The bus coupler will carry on flashing the error code even when you have cleared the fault and its operating mode will remain at “Stop“. The only way to restart the bus coupler is by switching the power supply off and on again.

You should not plug or unplug bus terminals from the series without first turning off the power. The circuitry of the bus terminals and the bus coupler is largely protected against damage, but if you modify the assembly while it is under power, malfunctions and damage cannot be ruled out.

If a fault occurs during normal operation, the error code will not be output on the LEDs until the bus coupler has been requested to diagnose the bus terminals. This diagnostic request is generated after the equipment is switched on.

2 DeviceNet coupler BK52xx in the DeviceNet

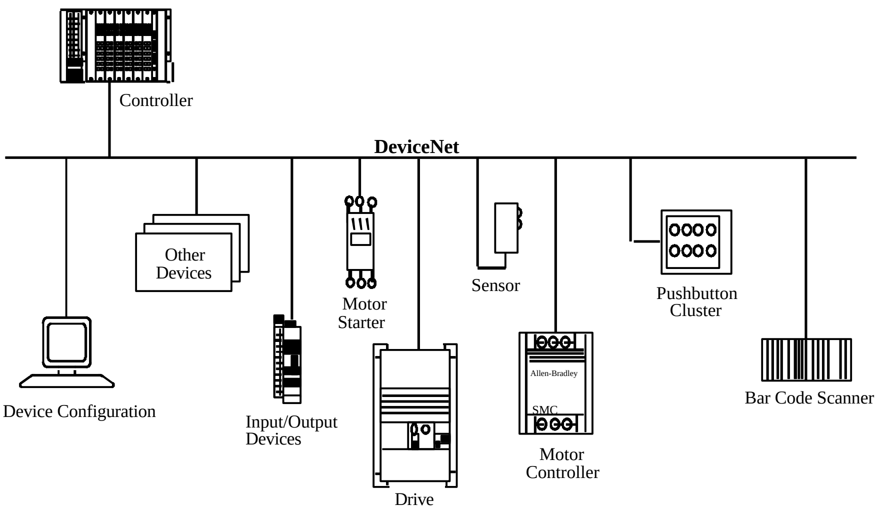
2.1 Introducing the system

DeviceNet

Bus power and terminal power are supplied separately. Both power supplies must be connected

DeviceNet is an open system based on the CAN principle which was developed a few years ago by the company R. Bosch. 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 which makes it possible to use the CAN protocol for industrial applications. The ODVA (Open DeviceNet Association) is an independent association which supports manufacturers and users of the DeviceNet system. The ODVA ensures that all devices which conform to the specification can operate together in one system regardless of their manufacture.



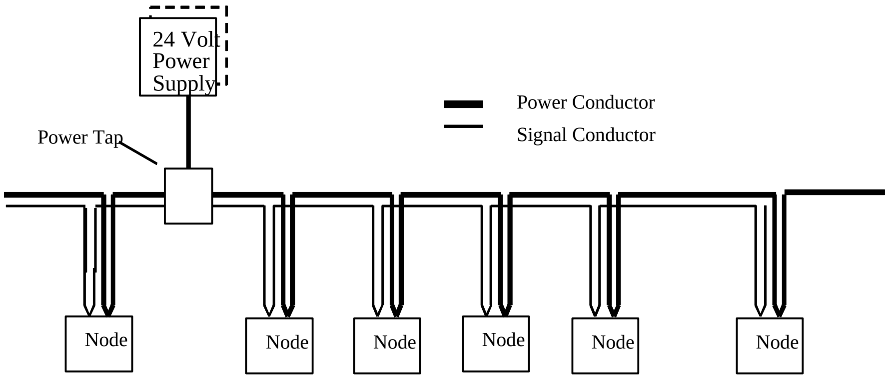
Sample for a DeviceNet network

CAN’s bit arbitration procedure makes it theoretically possible to operate communication networks using master/slave and multimaster access methods. The bus coupler BK5200 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 will also support multimaster operation.

The bus coupler does not receive its operating 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) which 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 peripherals side and dispense with the decentralized power supply.

Bus cable

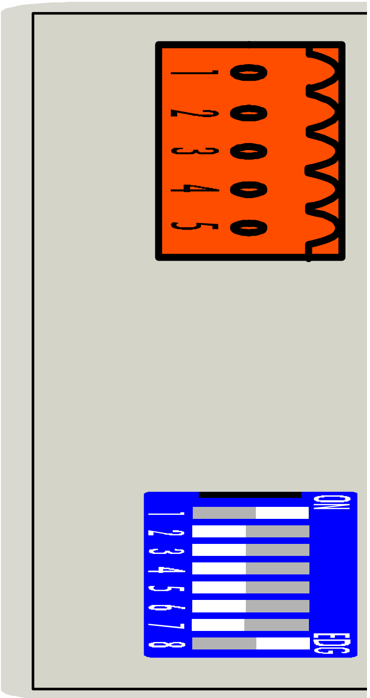
The bus cable consists of two pairs of shielded twisted-pair wiring, one for the data transfer and one for the power supply. The latter can carry currents of up to 8 amperes. The maximum possible length of a line depends essentially on the Baud rate. If you choose the highest Baud rate (500kBaud) you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



The bus cable may consist of a main line with branch lines up to 12m long. It is important that both ends of the main line should carry 121Ω terminating resistors. You can operate up to 64 subscribers 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 firmly to the bus cable.

Using the Software Manager to set up the system parameters.

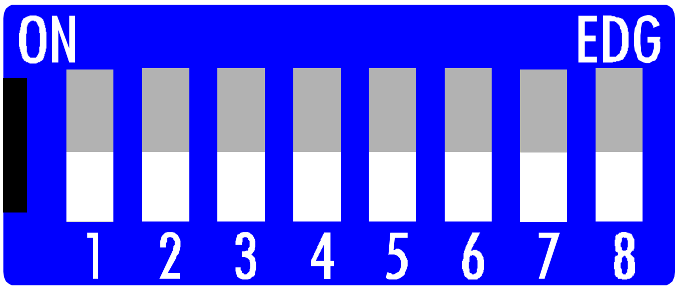
It is advisable to use a special software program to set up the system parameters, for example Allen Bradley's "Software Manager" which enables you to record the parameter data in the master. When it is first switched on, the master will compare its stored settings with the actual configurations of each of the stations. The exchange of user data between master and slave will not be set up 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 fieldbuses.



BK5200 DeviceNet

2.2 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 kBd							off	off
250 kBd							on	off
500 kBd							off	on
(Default) 125 kBd							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, 2^0, and switch 6 the highest value bit, 2^5. In the setting labeled ON, the bit is set.
You can select the MAC ID from the range 0 to 63.

Switch on the bus coupler

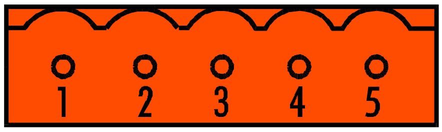
When you have set all the DIP switches to the desired configuration you can switch on the bus coupler. Any changes you make to the switches while the system is in operation will have no effect until the next time it is switched on.

Pin-out

DeviceNet connection

The bus and the terminals have separate power supplies. Both power supplies must be connected

A 5-pin plug is supplied for connecting the DeviceNet bus cable. When it is plugged into the bus coupler, pin 1 is at the top. The illustration shows the socket which is located on the bus coupler. The power supply delivered 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-out of DeviceNet connection	
1	V+
2	CAN-H
3	Drain
4	CAN-L
5	V-

2.3 Exchanging data

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

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

Data is transferred between masters and slaves in the form of objects. The bus coupler recognizes two objects: an input object and an output object. You can use the Software Manager to map the input/output bytes onto specific memory areas in the control unit. 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, this 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.

First the data from all the analog outputs

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.

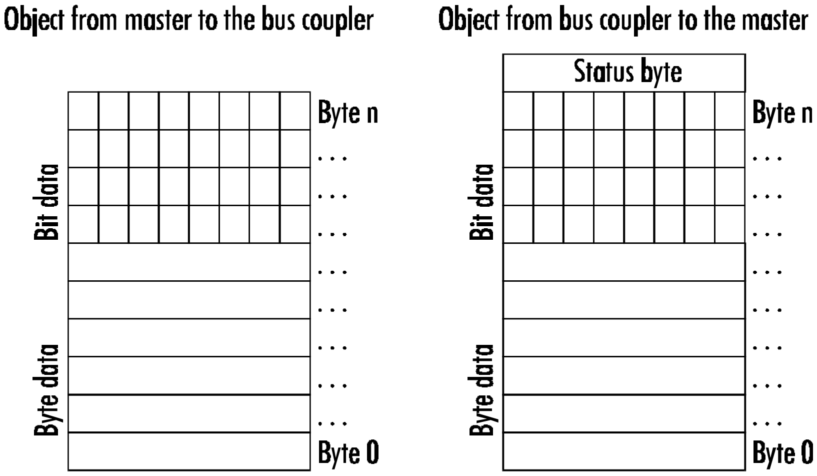
then the data for the digital outputs,
in each case, transferred as bytes

The first 4 bytes of an object which is transferred to the terminal row are assigned to the first analog output terminal, this 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 row. Any other terminals between the first and second analog output terminals are disregarded.

When the last analog output terminal in the terminal row 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.

Some of the bits in the last byte may be unused

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, if so they will be disregarded.
Additional bytes are read from the data string until the last digital output in the terminal row 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.



Data string 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.

first byte-oriented data,

The byte-oriented data contains the values from the analog inputs and the bit-oriented data the values from the digital inputs.
The first four bytes contain the data from the first analog input terminal in the terminal row, 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 row is not a multiple of 8, the last data byte will contain one or more superfluous bits.

Status byte at the end of the string 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, this returns the status of the terminal row. Its value corresponds to the status displayed on the I/O LEDs on the bus coupler: while the terminal row 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.

2.4 Light-emitting diodes

	Module status LEDs “MS“	
LED “RUN“	The green LED flashes:	Configuration is incorrect
	The green LED is permanently lit:	Status is O.K.
LED “OVERFL“	The red LED flashes:	Receive queue overflow
	The red LED is permanently lit:	Status is O.K.
	Network status LEDs “NS“	
LED “CONNECT“	The green LED flashes:	Bus coupler is ready for communication, but not yet assigned to the master.
	The green LED is permanently lit:	Bus coupler is assigned to the master, data is being exchanged.
LED “BUS OFF“	The red LED flashes:	Timeout on I/O connection
	The red LED is permanently lit:	BUS OFF: CAN error, subscribers have identical node addresses.
	Input/output status “I/O“	
LED “I/O RUN“	The green LED is lit:	The terminal row is working perfectly
LED “I/O ERR“	The red LED is lit:	I/O error

2.5 Vendor ID

The vendor ID is # 108.

DeviceNet Group

The bus coupler BK5200 is invariably a Group 2 device.

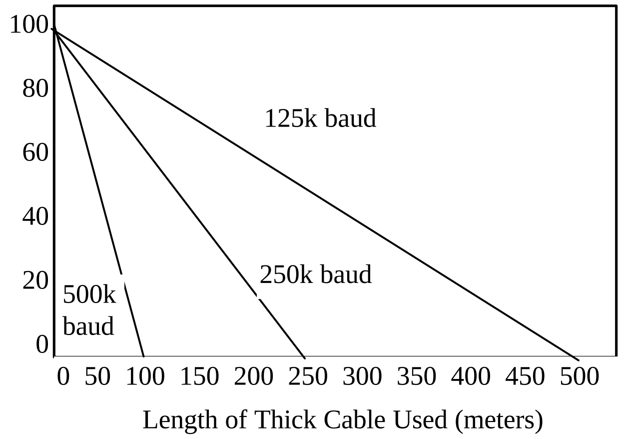
IDENTIFIER BITS											MESSAGE ID MEANING
10	9	8	7	6	5	4	3	2	1	0	
1	0	MAC ID						Group 2 Message ID			Group 2 Messages
1	0	MAC ID						0	0	0	Group 2 Message Identifier
1	0	MAC ID						0	0	1	
1	0	MAC ID						0	1	0	
1	0	MAC ID						0	1	1	
1	0	MAC ID						1	0	0	
1	0	MAC ID						1	0	1	
1	0	Destination 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 used identifier

2.6 Maximum cable length

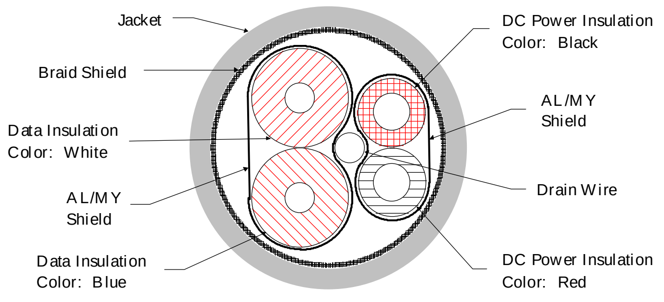
The maximum length of cable which can be used depends on the selected Baud rate. The following lengths should be understood as the total length of the main line plus any branch lines.

125kBaud	500m
250kBaud	250m
500kBaud	100m

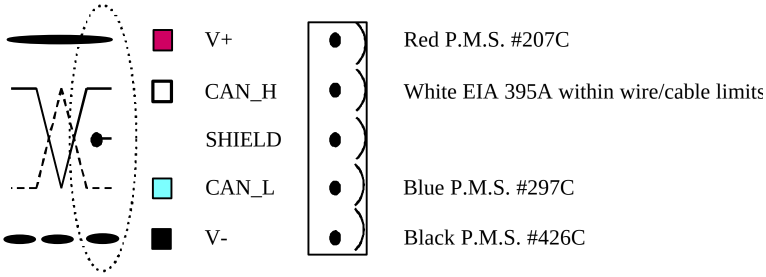


$L_{thick} + 5 \times L_{thin} = 500$	at 125Kbaud
$L_{thick} + 2.5 \times L_{thin} = 250$	at 250Kbaud
$L_{thick} + L_{thin} = 100$	at 500Kbaud

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



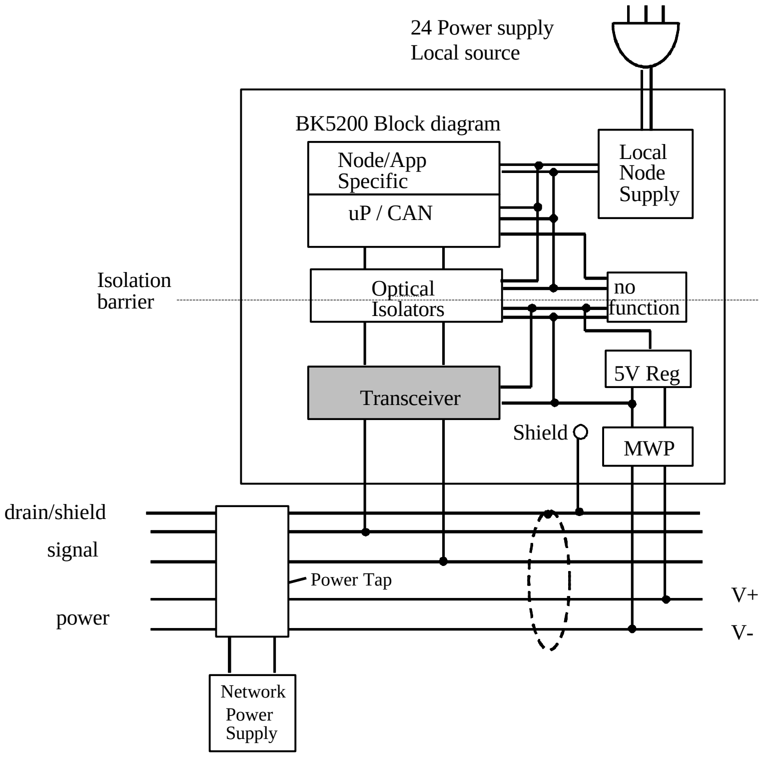
The cable consists of two shielded wire pairs. One pair carries out the transmission. The second pair distributes the supply power.



Connector wiring information

2.7 Potential isolation

The bus coupler BK5200 offers a potential isolation between the DeviceNet bus cable and the communication electronic of the bus coupler.



Potential levels of the BK5200

3 Appendix

3.1 Sample arrangement of a process image in the bus coupler

The following example will illustrate the assignment of input/output channels to the process image. Our sample construction is to consist of the following bus terminal components:

For this configuration the bus coupler will create the list of assignments shown below

Position	Function component on the track
POS01	Bus coupler
POS02	2-channel digital input
POS03	2-channel digital input
POS04	2-channel digital input
POS05	2-channel digital input
POS06	2-channel digital input
POS07	2-channel digital output
POS08	2-channel digital output
POS09	2-channel digital output
POS10	2-channel analog input
POS11	2-channel analog output
POS12	2-channel analog output
POS13	2-channel analog input
POS14	Power input terminal
POS15	2-channel digital input
POS16	2-channel digital input
POS17	2-channel digital input
POS18	2-channel digital output
POS19	2-channel digital output
POS20	2-channel analog output
POS21	End terminal

By default all analog terminals are mapped without a Control/Status byte. Please read the technical documentation for the analog terminals for further details.

Area for byte-oriented data, analog outputs

Relative byte address	Bit position	Process image in the control unit	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	POS19
10, 11	none	O10, O11	POS19

Area for bit-oriented data, digital outputs

Relative byte address	Bit position	Process image in the control unit	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	Process image in the control unit	Position in the block
0, 1	none	I0, I1	POS10
2, 3	none	I2, I3	POS13

Area for bit-oriented data, digital inputs

Relative byte address	Bit position	Process image in the control unit	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

The items POS14 and POS21 are not relevant to data exchange and do not appear in the list. If a byte is not fully used, for example I8, the bus coupler pads its remaining bits with zeroes.

Overview of the distribution of the process image in the bus coupler:

Output data in the bus coupler

O0 ... ... O11	byte-oriented data
O12 O13	bit-oriented data

Input data in the bus coupler

I0 ... ... I3	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 Profibus system you can use the bus master to enter these addresses at any desired position in the process image of the control unit. You can use the configuration software of the master to assign the bytes to the addresses in the process image of the control unit.

3.2 Representation of analog signals in the process image

Three input bytes and three output bytes are required in the process image for each analog channel. Two bytes represent the value as an unsigned integer, i.e. 15 bits and sign. This data format is used regardless of the actual resolution. For example, with 12-bit resolution, the least significant four bits are meaningless. The low value byte has control and status functions. You can use the control byte to set up various operating modes. The lowest six bits can be used as the address bits for writing and reading a register set using string communications. A register set consists of 64 registers.

I/O bytes of an analog channel in the process image

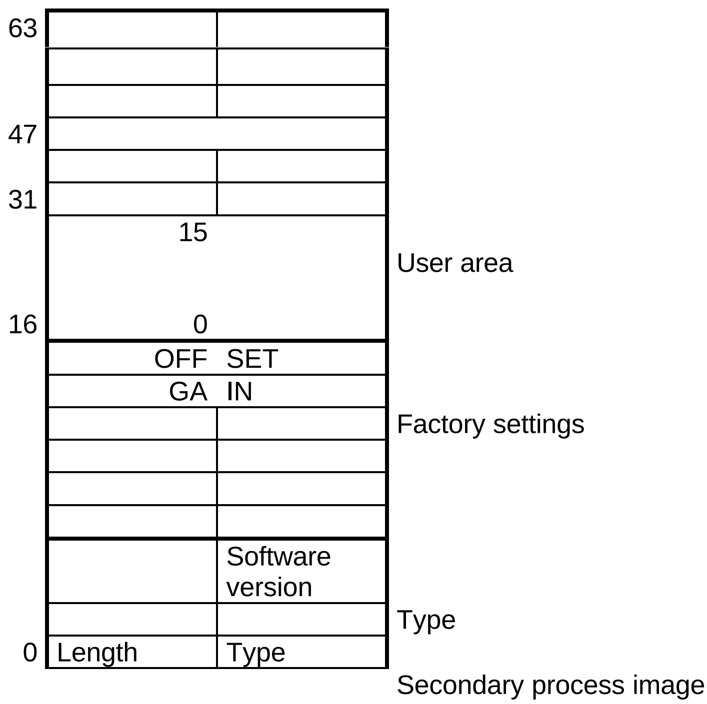
Output byte 1	Output byte 0	Control byte

Input byte 1	Input byte 0	Status byte

Significance of the control/status bytes for accessing the register model

BIT 7	0 = NORMAL MODE,	1 = CONTROL MODE
BIT 6	0 = READ,	1 = WRITE
BIT 5	Register address, MSB	
BIT 4	Register address	
BIT 3	Register address	
BIT 2	Register address	
BIT 1	Register address	
BIT 0	Register address, LSB	

Register set of an analog channel



The significance of the registers and status bytes is explained in the data sheets for the corresponding bus terminals. The construction of the module is identical for bus terminals with more extensive signal processing.