BERGHOF
AUTOMATIONSTECHNIK
Unternehmen der ZUNDEL Holding

Introduction

CANtrol *powertrack*

V.1.01

User Handbook

Automation System

CANtrol®

Disclaimer

The content of this publication was checked for compliance with the hardware and software described. However, discrepancies may arise, therefore no liability is assumed regarding complete compliance. The information in this document will be checked regularly and all necessary corrections will be included in subsequent editions. Suggestions for improvements are always welcome.

Subject to technical changes.

Trademark

CANtrol® // is a registered trademark of BERGHOFAutomationstechnik GmbH

General Information on this Manual

Content:
This manual describes the automation system CANtrol *powertrack* and its modifications. The product-related information contained herein was up to date at the time of publication of this manual.

Completeness:
This manual is complete only in conjunction with the user manual entitled

'Introduction
to CANtrol Automation System'

and the product-related hardware or software user manuals required for the particular application.

Standards:
The CANtrol automation system, its components and its use are based on International Standard IEC 61131 Parts 1 to 4 (EN 61131 Parts 1 to 3 and Supplementary Sheet 1).
Supplementary Sheet 1 of EN 61131 (IEC 61131-4) entitled 'User Guidelines' is of particular importance for the user.

Order numbers:
Please see the relevant product overview in the 'Introduction to CANtrol Automation System' manual for a list of available products and their order numbers.

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Update

Version	Date	Subject
1.01	16.08.06	First version

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Contents

1. General Instructions

1.1. Hazard Categories and Indications

The indications described below are used in connection with safety instructions you will need to observe for your own personal safety and the avoidance of damage to property.

These instructions are emphasised by bordering and/or shading and a bold-printed indication, their meaning being as follows:

⚠ DANGER	**Immediate danger** Failure to observe the information indicated by this warning will result in death, serious injury or extensive property damage.
⚠ WARNING	**Potential danger** Failure to observe the information indicated by this warning may result in death, serious injury or extensive property damage.
⚠ CAUTION	**Danger** Failure to observe the information indicated by this warning may result in injury or property damage.
ℹ NOTICE	**No hazard** Information indicated in this manner provides additional notes concerning the product.

1.2. Qualified users

Qualified users within the meaning of the safety instructions in this documentation are trained specialists who are authorised to commission, earth and mark equipment, systems and circuits in accordance with safety engineering standards and who as project planners and designers are familiar with the safety concepts of automation engineering.

1.3. Use as Prescribed

This is a modular automation system based on the CANbus, intended for industrial control applications within the medium to high performance range.

The automation system is designed for use within Overvoltage Category I (IEC 364-4-443) for the controlling and regulating of machinery and industrial processes in low-voltage installations in which the rated supply voltage does not exceed 1,000 VAC (50/60 Hz) or 1,500 VDC.

Qualified project planning and design, proper transport, storage, installation, use and careful maintenance are essential to the flawless and safe operation of the automation system.

The automation system may only be used within the scope of the data and applications specified in the present documentation and associated user manuals.

The automation system is to be used only as follows:

- as prescribed,
- in technically flawless condition,
- without arbitrary or unauthorised changes and
- exclusively by qualified users

The regulations of the German professional and trade associations, the German technical supervisory board (TÜV), the VDE (Association of German electricians) or other corresponding national bodies are to be observed.

Safety-oriented (fail-safe) systems

Particular measures are required in connection with the use of SPC in safety-oriented systems. If an SPC is to be used in a safety-oriented system, the user ought to seek the full advice of the SPC manufacturer in addition to observing any standards or guidelines on safety installations which may be available.

WARNING	**As with any electronic control system, the failure of particular components may result in uncontrolled and/or unpredictable operation.** All types of failure and the associated fuse systems are to be taken into account at system level. The advice of the SPC manufacturer should be sought if necessary.

2. General Information Regarding the CANtrol *powertrack*

2.1. Notes Concerning This Manual

Contents	This manual describes the principles of the CANtrol *powertrack* automation system for contact-line-supplied conveyor systems.
Applicability	This manual contains the supplementary information to the "*Introduction to the CANtrol Automation System*" manual and related to the CANtrol *powertrack*, valid at the time of the manual's publication. This manual is only comprehensive when used in conjunction with the "*Introduction to the CANtrol Automation System*" manual and the user manuals required for the individual application in question.
⚠ CAUTION	**The contents of this documentation presuppose a familiarity with the information provided in the "*Introduction to the CANtrol Automation System*" manual!** You must familiarize yourself with this information. The manual here deals only with those features related specifically to the CANtrol *powertrack* system.
EU Machinery Guideline	The CANtrol *powertrack* system does not represent machinery within the context of the EU Guideline, "Machinery". Therefore, the CANtrol *powertrack* system requires no conformity declaration in the sense of this EU Guideline. The CANtrol *powertrack* system forms part of the electrical installation of a machine. It must therefore be included in the conformity declaration process by the machinery manufacturer.
NOTICE	Modifications may be necessary in individual instances due to ongoing technical development. Any such modifications are noted and explained in the individual user manual.
Order numbers	Please refer to the *"Introduction to the CANtrol Automation System"* manual for a listing of available articles and their order numbers.

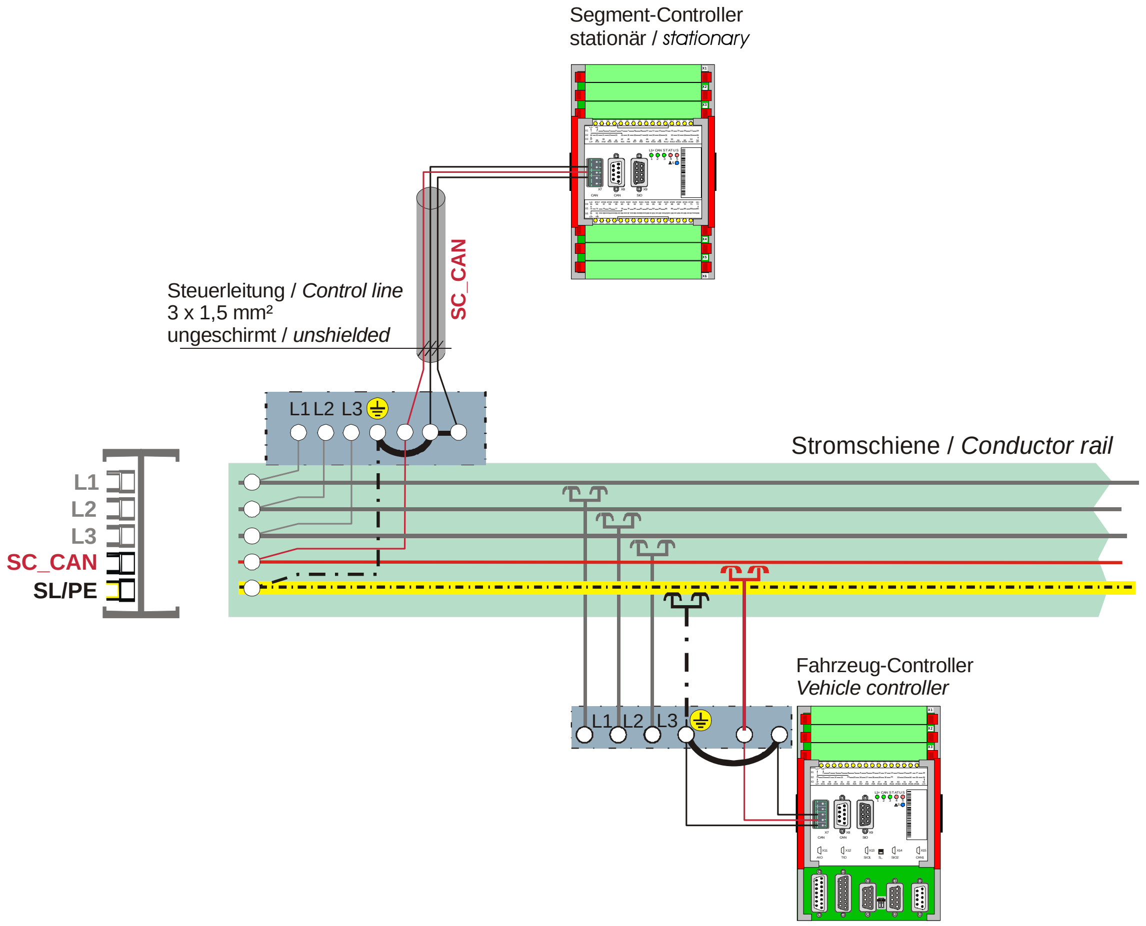
2.2. Application Area

CANtrol *powertrack* is a CAN bus-based automation system for controlling contact-line-supplied conveyor systems such as those found in, for example, electric overhead or electric pallet conveyors, rack stocking devices and similar equipment. The CAN contact line is known as the SC_CAN.

Only one additional conductor rail with a current collector is required for the SC_CAN which communicates directly with the individual vehicles without the need for any additional converters or amplifiers.

The PLC controller in every vehicle available in this system allows complex movement strategies and vehicle functions to be applied.

Anwendungsbeispiel / Prinzipdarstellung
Example of application / Principle draw



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2.3. Physical Characteristics

Contact-line-supplied conveyor systems are strongly affected by switches, segment transitions, etc. Therefore, the continuous communication between the control system and the vehicles must be able to meet exacting signal technology demands.

WARNING

Diagnostic, maintenance and work stations must always be designed as separate segments in which the SC_CAN bus can be switched off.

The voltage level of the transmission circuit for the SC_CAN signals is 85 V (110 V) at 25 Ohm. Based on the employed voltage levels all signal-carrying lines must be designed with the same degree of contact protection as the power supply (230 / 400 V).

CAUTION

Directly connecting a CAN bus analyzer or other conventional CAN components to the SC_CAN bus can result in these components being destroyed. Any such connection is therefore prohibited.

In CANtrol *powertrack*, the physical transmission layer for the CAN signal has been specifically adapted to the particular data communications conditions encountered in contact-line-supplied conveyor systems:

- Asymmetrical wiring with one side referenced to ground is employed.
- The SC_CAN signal is capacitive-coupled and is resistant to brief contacts with the alternating current network.
- The voltage level of the transmission circuit for the SC_CAN signals has been raised in comparison with standard CAN. The signal shape has also been adjusted.
- In order to meet the varying requirements of conveyor systems, the controllers are available with two different transmission pulse strengths:

  Type T1 = 0.1 mJ/pulse
  Type T2 = 0.4 mJ/pulse

- Due to its higher transmission capability, type T2 is better suited for installations requiring a larger number of stub lines or where a larger number of vehicles per segment are used.
- Type T1, on the other hand, allows higher transmission rates to be employed.

NOTICE

The newest generation of *powertrack* cell controllers offers a transmission pulse strength which lies between the values for T1 and T2.

This means that, at 50 Kbit/sec., these cell controllers correspond to the maximum performance parameters of both T1 as well as T2. This also ensures that these devices will communicate at 50 Kbit/sec. with devices having T1 or T2 performance characteristics. New installations are designed to operate exclusively at 50 Kbit/sec.

2.4. Power Supply

Power to the CANtrol *powertrack* controller is to be supplied from a regulated power supply providing a nominal 24 V DC.

Power to the SC_CAN bus is supplied from the CANtrol *powertrack* controller. No external energy source is required to supply the SC_CAN.

NOTICE	Please refer to the associated product manuals for further information regarding the power supply to the individual CANtrol *powertrack* controllers.

2.5. Electromagnetic Compatibility

In contrast to conventional bus systems, reliable communications via contact conductors is only possible at comparatively high current and voltage levels.

Increased radio interference voltages can be anticipated in the lines supplying power to the conductor rails.
Therefore, the CANtrol *powertrack* system's connecting lines must be installed away from other power supply lines and data cables, e.g., in separate conduits.

NOTICE	**As an additional measure, we recommend equipping all power infeeds to the installation with appropriate filter components.** This will help ensure that radio interference limit values will be maintained on lines outside the installation.

3. Project Planning for CANtrol *powertrack* Networks

3.1. Principles

Familiarity with the following represents the foundation for project planning of a contact-line-supplied conveyor system with CANtrol *powertrack*:

- The installation topology (total span, segment lengths, etc.);
- The impedance level of the conductor rail (rail type);
- The number of subscribers (vehicles);
- The required data transmission rate;
- The available power supply output.

Installation topology

The basic prerequisite is a **linear structure** of the SC_CAN bus.
Stub lines and cable transitions negatively influence the performance data of CANtrol *powertrack* systems.

Impedance level

In order for project planning of CANtrol *powertrack* to be reliable, the impedance level (Z_0) of the contact line system must be known.
This value can be obtained from the manufacturer of the conductor rail system. On request, the impedance level can also be measured by BERGHOF Automationstechnik.

NOTICE

The information provided in this manual applies only to systems with an impedance level, Z_0 = 45 to 60 Ohm.

If the impedance level lies outside this range, project planning must be adjusted to the total system.

In any case, we strongly recommend that you consult with BERGHOF Automationstechnik.

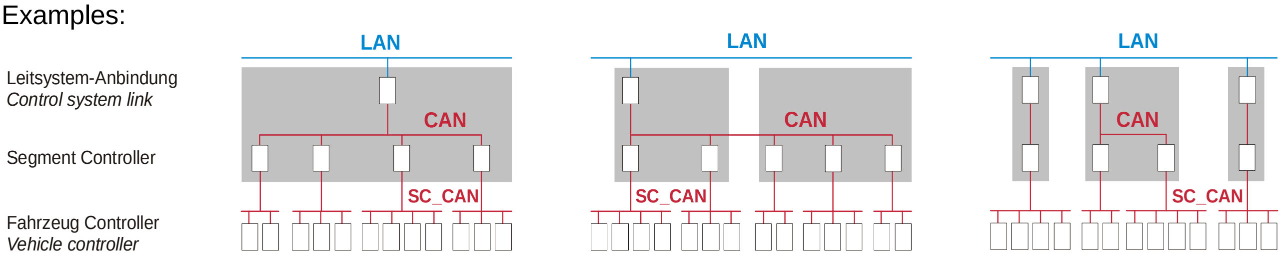
3.2. System Architecture

In principle, there are no differences between the structure of the SC_CAN bus in CANtrol *powertrack* systems and in “normal” CAN bus communications networks.

NOTICE	The basic prerequisite is a **linear structure** of the SC_CAN bus.

In larger installations utilizing parallel rail layouts or radial segment arrays, the option of collecting segment controllers in a switch cabinet exists. These segment controllers can then have a common link to the control system.

Examples:



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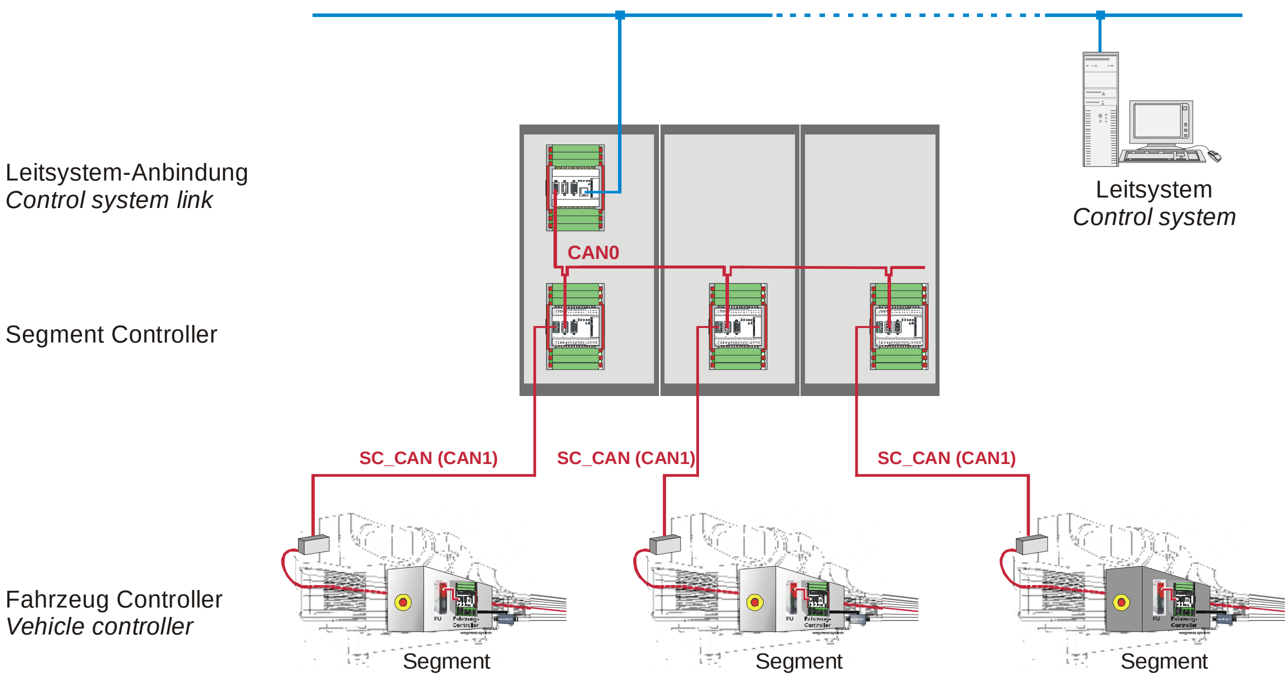
Segment controllers

As a rule, the CANtrol *powertrack* cell controllers for the individual segments are located in stationary switch cabinets. From a data technology aspect, the controllers are “linked” to the higher-level control system via CAN, Ethernet or serial ports. These stationary cell controllers are referred to as “segment controllers”.

Vehicle controllers

The segment controllers’ SC_CAN buses are connected to the conductor rail of their associated segment via a connection line.
From the conductor rail, the SC_CAN bus is led across the current collector to the CANtrol *powertrack* cell controller on the vehicle, referred to as the vehicle controller.



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3.3. Wiring an SC_CAN Bus Segment

Wire the individual segments through the conductor rail connection cabinet and not through additional terminal cabinets!

Line structure

SC_CAN bus segments must always be laid out as a line.
Ring structures or radial wiring is not permitted.
To avoid severe attenuation due to transformer effects, lines within individual segments should be kept short.

Termination

The SC_CAN bus must be terminated with the specified terminating resistor at both the beginning and the end of every segment (line).
At the beginning of the segment, termination takes place directly at the segment controller.
At the end of the segment, the terminating resistor is installed in the conductor line's connector box.

In the CANtrol *powertrack* communication concept, the resistor for the RC section (CTR-SC) corresponds to the impedance resistor, Z_0. The built-in condenser provides additional signal attenuation. This RC section is very important for a uniform signal quality and therefore for the reliability of the system as a whole.

Within the frequency range for data transmission, the resistor becomes effective at the level of the conductor rail array impedance. For a 50 Hz network frequency, the serial capacitors (47 nF) make the impedance significantly higher so that a short circuit to the mains power supply (230 V) will not result in destruction.

NOTICE	The signal must be able to travel to and return from the most distant subscribers within a "bit time". All reflections as well as any possible multiple reflections which are underway for longer than this bit time must be sufficiently attenuated so that they remain below the reception threshold. This can be optimally achieved by terminating both ends of the line with their characteristic impedance (surge impedance).

Grounding

Pay particular attention to grounding and to short ground connection lines with adequate conductor diameters.

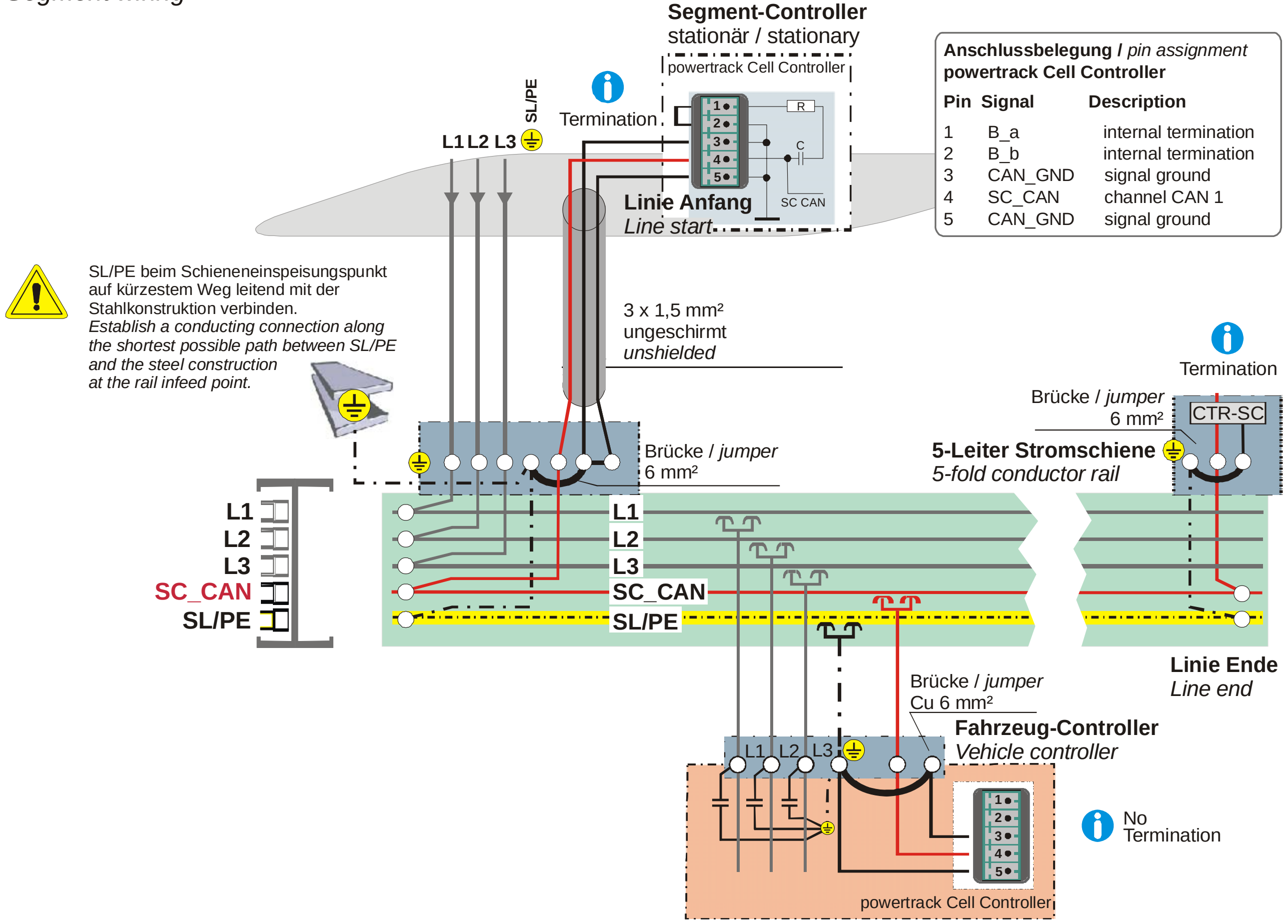
CAUTION	The SL/PE rail must have a well conducting connection to the steel structure or the bearer rail near every infeed point. This suppresses effects such as segment cross-talk in close proximity to the infeed points. The cell controllers on the vehicles (vehicle controllers) may not be terminated!

3.3.1. 5-Fold Conductor Rail Systems

The architecture can be designed as a 5-condutor system provided that filter capacitors are available between the external conductors or lines (L1; L2; L3) and SL/PE on the vehicles.

When filter capacitors are employed, the transmission quality of 5-conductor systems is nearly equal to that of 6-conductor systems.

Segment Verdrahtung
Segment wiring



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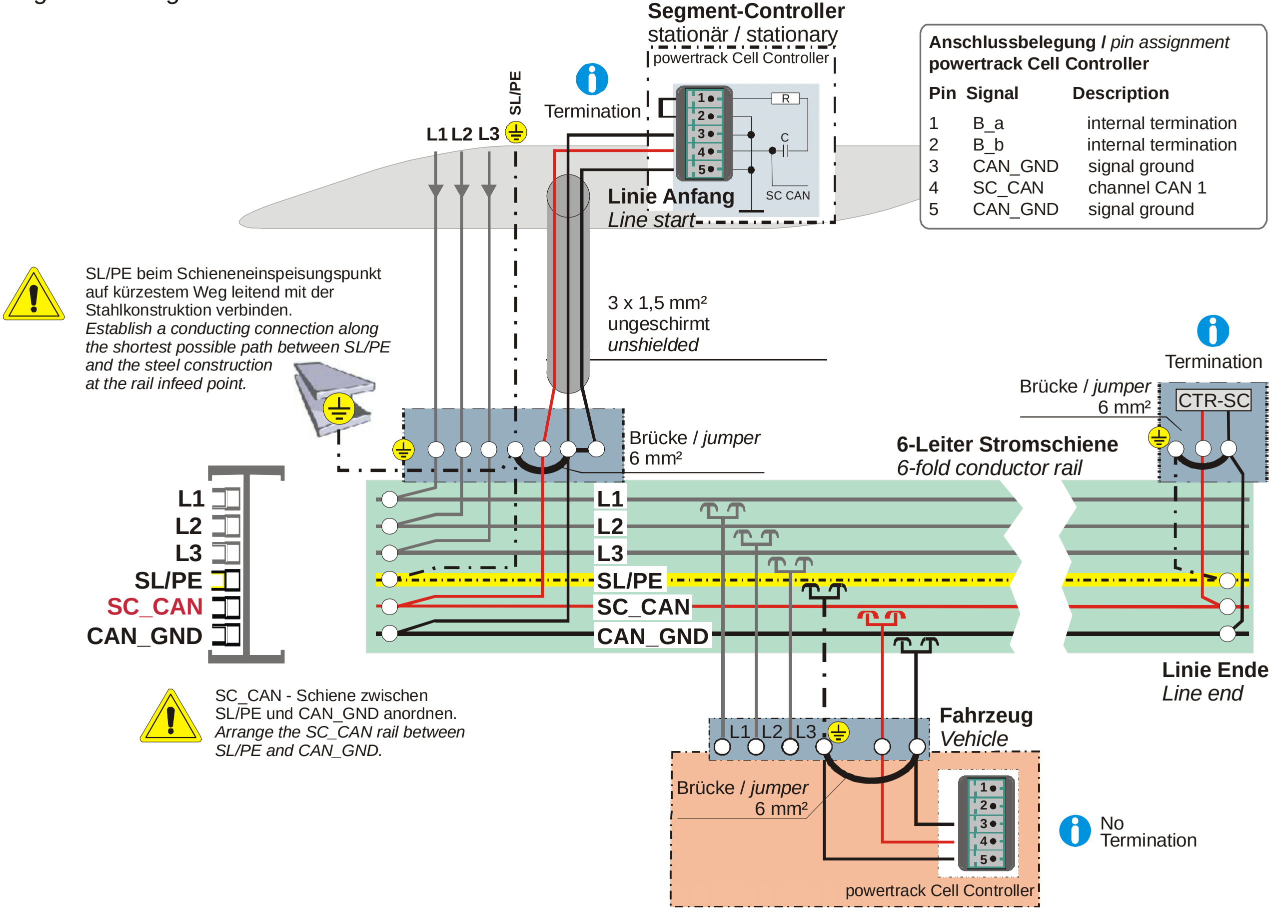
3.3.2. 6-Fold Rail System with a Separate CAN_GND Rail

If two conductor rails are available for data transmission, we recommend using a 6-conductor system.

In this arrangement, CAN_GND must be connected to SL/PE at all infeed points, at the segment ends and on the vehicles.

Segment Verdrahtung
Segment wiring



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3.4. Installation Layout

Several constraints must be taken into consideration when subdividing a complex installation into individual CANtrol *powertrack* segments.

- In general, the choices for possible segment lengths decrease as the transmission rate increases.
- Within a segment, stub lines, terminal points (cable / rail) as well as the number of vehicles all influence the signal level.
- CANtrol *powertrack* Cell controllers are available in versions offering different transmission performance. Type T1 cell controllers permit higher transmission rates than do Type T2 cell controllers which, in turn, allow a greater number of vehicles per segment, but at the expense of the maximum transmission rate.
- Because of the higher transmission performance offered by Type T2 cell controllers, the effect of stub lines and terminal points on the overall system is reduced.

The following table shows the maximum segment lengths and the maximum number of vehicles in relation to the transmission rate.

⚠ WARNING	**Under no circumstances may the maximum segment lengths indicated in the table be exceeded!** The length of the feeder cable must also always be taken into account when determining the segment length.

	Type T1 cell controller [4]		Type T2 cell controller [4]	
Data rate [3]	**Max. segment length [2]**	**Vehicles per segment [1]**	**Max. segment length [2]**	**Vehicles per segment [1]**
83.3 Kbit/sec.	300 m	32	--------	--------
62.5 Kbit/sec.	350 m	32	--------	--------
50.0 Kbit/sec.	**400 m**	**32**	**400 m**	**64**
41.6 Kbit/sec.	600 m	32	600 m	64
35.7 Kbit/sec.	800 m	32	800 m	64

(1 The table values are based on a feeder cable length (current collector < > cell controller) of 1 m to the vehicles.

(2 Reducing the segment length creates reserves for stub lines and cable transitions.

(3 The data rate is assigned to the specified segment length based on design and must under no circumstances be exceeded.

(4 Transmission pulse strength: T1 = 0.1 mJ/pulse; T2 = 0.4 mJ/pulse

ℹ NOTICE	**A data rate 50 Kbit/sec. should be used for all new applications. This rate offers the best compromise between data transmission speed and segment length.** The latest generation of *powertrack* cell controllers has been optimized for 50 Kbit/sec.

3.4.1. General Project Planning Information

Principles	The principle that signals propagate at a finite speed is important in order to understand the physical processes involved. All lines connected to the SC_CAN bus must be viewed as waveguides. All portions of the line must exhibit the same characteristic impedance. If they do not, power losses at the cable/rail transition points as well as in stub lines must be taken into consideration.
Stub lines	Every branch (deviation from the linear structure) results in a weakening of the high frequency signals. In a branch, the signal energy is always split between the two branches. As long as the signal runtime in a stub is short relative to the pulse width of the signal in question, the signal reflected at the open end of the stub will, to a great extent, compensate for the energy loss. However, a portion will be scattered back into the line, thus reducing the energy of the ongoing signal.
Conductor rail	The conductor rail (contact line) itself is a good waveguide with a characteristic impedance of approx. 50 Ohm. Because the SC_CAN signal line lies directly next to the SL/PE rail, the SL/PE rail perforce acts as a return line for the HF signals, and one which is equal to the dedicated rail provided for this function (CAN_GND).
NOTICE	In order to ensure a low-loss line arrangement and good decoupling with respect to other signals, the SL/PE rail must have a conducting connection to the steel structure or the bearer rail near every infeed point.
Rail array	In contrast to the CAN bus which is tied to cables and has three signals: CAN_LO; CAN_HI; CAN_GND; the SC_CAN bus only communicates via the SC_CAN and CAN_GND signals. For communications via the conductor rail, the SC_CAN bus only needs one conductor rail as the data line. A separate return line is not necessary.
Data lines	The data connection line connects the stationary segment controller to the conductor rail. With regard to the characteristic impedance, Z_0, any unshielded, non-flex 3x1.5 mm^2 control line commonly employed in installation design is suitable (e.g., Lapp Ölflex). Make sure that one lead is assigned to the SC_CAN bus signal and the remaining two leads are assigned to CAN_GND. The two leads assigned to CAN_GND must both always be connected to either SL/PE or a separate ground rail.
NOTICE	**An unshielded non-flex, 3x1.5 mm^2 control line is only suitable as a data connection line in the above-described arrangement.** If only two conductors (e.g., SC_CAN bus and CAN_GND) are used, a low attenuation transition to the conductor rail system is no longer assured!
Current collectors	Both the current collectors for power transmission as well as those for data transmission must operate reliably and without interruption. We recommend the use of dual current collectors. Experience gained with Cu conductor rails and Cu/graphite contact lines have shown that there are no special material pairing requirements with regard to the conductor rails and contact lines provided that the installation is weatherproof.
NOTICE	Please refer to the individual manufacturer's recommendations with regard to the care and maintenance of conductor rail systems.

E-STOP sections

When subdividing the rail network into CANtrol *powertrack* segments, pay particular attention to the energy infeed and the associated subdivision into E-STOP sections.
Ideally, CANtrol *powertrack* segments should be designed as sub-elements of individual E-STOP sections.

⚠ WARNING

Never design a CANtrol *powertrack* segment so that it crosses several E-STOP sections!

Diagnostic stations

Diagnostic, maintenance and workstations should always be designed as separate segments with an SC_CAN bus shutoff.

⚠ WARNING

The voltage level of the transmission circuit for the SC_CAN signals is 85 V (110 V) at 25 Ohm.

Based on the employed voltage levels all signal-carrying lines must be designed with the same degree of contact protection as the power supply (230 / 400 V).

Switch activation

When switches are activated, errors referred to as “error frames” arise at the SC_CAN.
These errors can be practically eliminated by the employment of a so-called “Movi Switch®” (Semiconductor switch of the company SEW) with zero-passage switching in the switch controller.
As a general protective measure, we recommend switching three capacitors between the external conductors (L1, L2, L3) and PE.

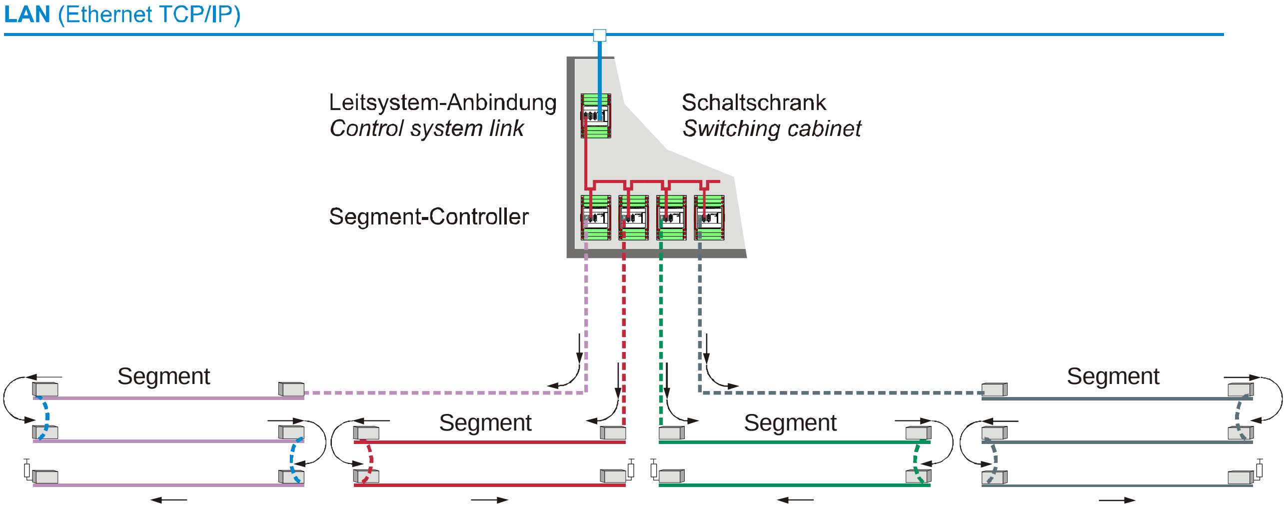
3.4.2. Segmentation

Due to installation-specific requirements, rail network topology can differ greatly from one system to another. Thus, the subdivision into individual segments is subject to a large number of criteria. Aside from the existing mechanical and structural installation conditions, the data technology demands placed on the CANtrol *powertrack* system must also be considered.

Segmentation is always required whenever the total length can no longer be covered by a single CANtrol *powertrack* segment.

NOTICE	
	The basic prerequisite is a **linear structure** of the SC_CAN bus.

Example: Principle of segment formation within a linear structure.



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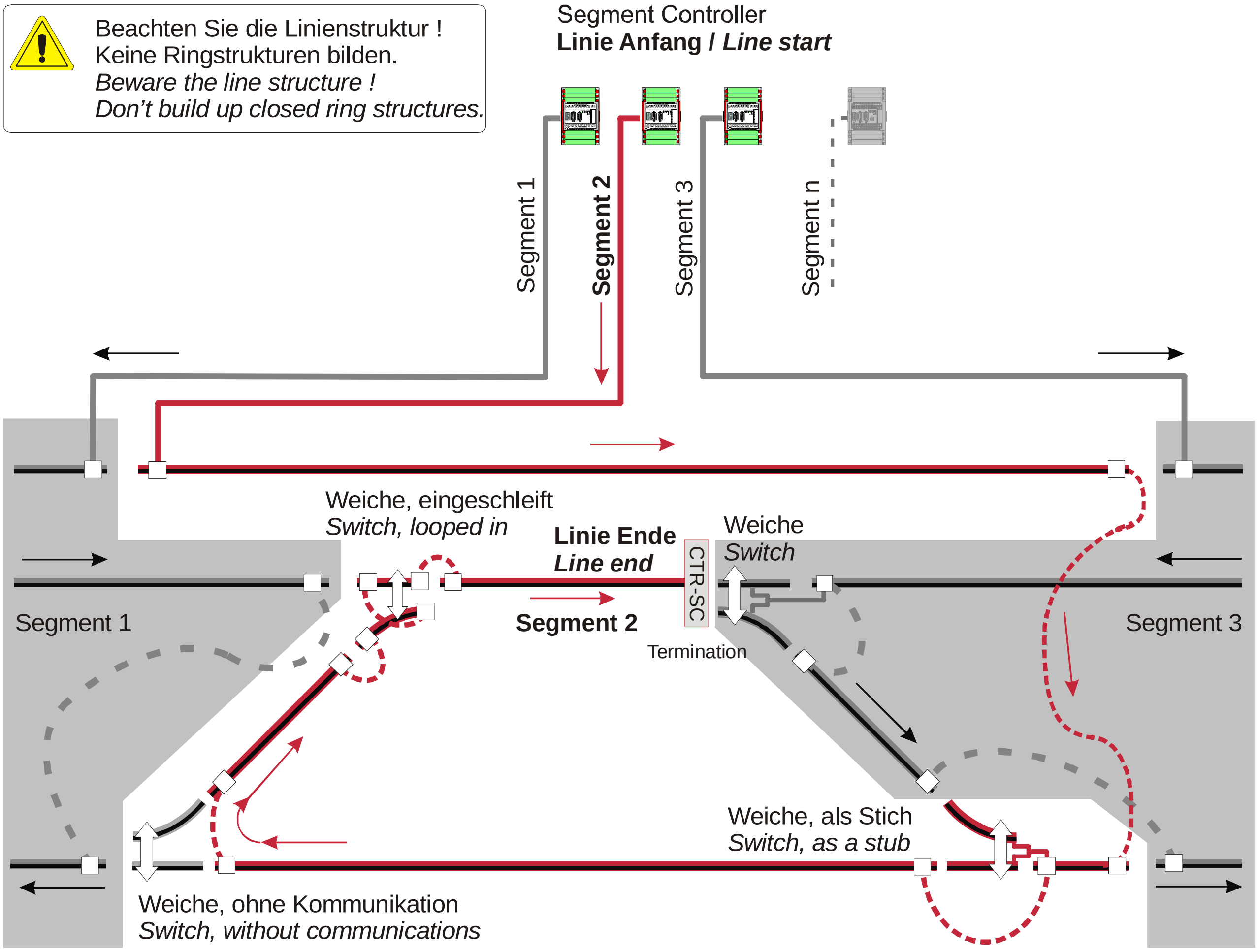
3.4.3. Line Layout at Transitions and Switches

Depending on the type and number of branching points, an installation's rail system can be extremely complex.
The linear structure required for CANtrol *powertrack* segments MUST therefore also be maintained across the individual branching points (e.g., switches).

Various solutions are possible to link the movable components of the rail system (switches) to the line layout.

- The individual rail sections can be looped into the line.
- The individual rail sections can be wired as stubs.
- The individual rail sections can simply be excluded.

Example: Line structure of a CANtrol *powertrack* segment across switches



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Shorter sections

Check whether shorter sections (e.g., switches) can be installed without communications. The installation time and expense required to construct totally gap-free communications can be very large and is frequently not necessary for the installation's proper operation.
For shorter stretches which do not necessarily require communications, a decision must be made whether these stretches can be laid out as stubs or whether they are to be looped into the segment line.

Bear the following points in mind:

- Only include unavoidable connection boxes.
- A connection can only be considered to be looped in if the forward and return lines are each a separate, 3-wire cable (e.g., Lapp Ölflex) with appropriate characteristic impedance.
- The total length of all stub lines within a segment may not exceed 20 m.
  In stub lines, the SC_CAN bus signal may also be carried through multiple-pin control lines.

NOTICE

When calculating the stub line length, remember that, aside from switches, every connection between the current collector and the vehicle controller represents a separate stub line.

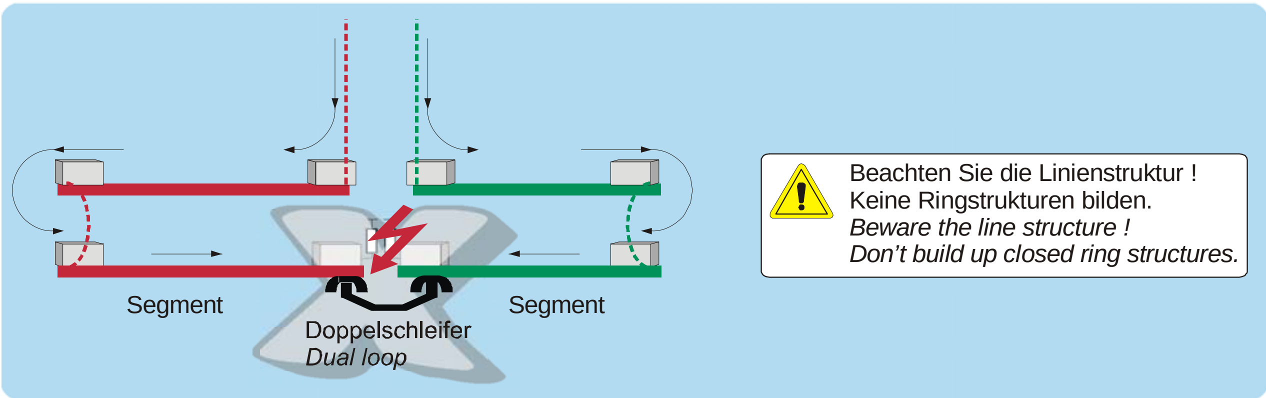
3.4.4. Segment Transitions, Rail Sections and Switches

Depending on the arrangement of the rail system, points at which the conductor rail is interrupted must be considered separately.

Rail interruptions between CANtrol *powertrack* segments must be constituted in such a way that no contact is created by the current collector as the vehicle passes over the cut.

Particularly with regard to switches there is a risk that the linear structure of the CANtrol *powertrack* segment will be altered when the current collector passes over them.
Accordingly, transition or insulation techniques must be applied to rail interruptions on the installation side to ensure that the functionality of the CANtrol *powertrack* segment is not impaired.

Example 1: Current collector simultaneously contacts two segments



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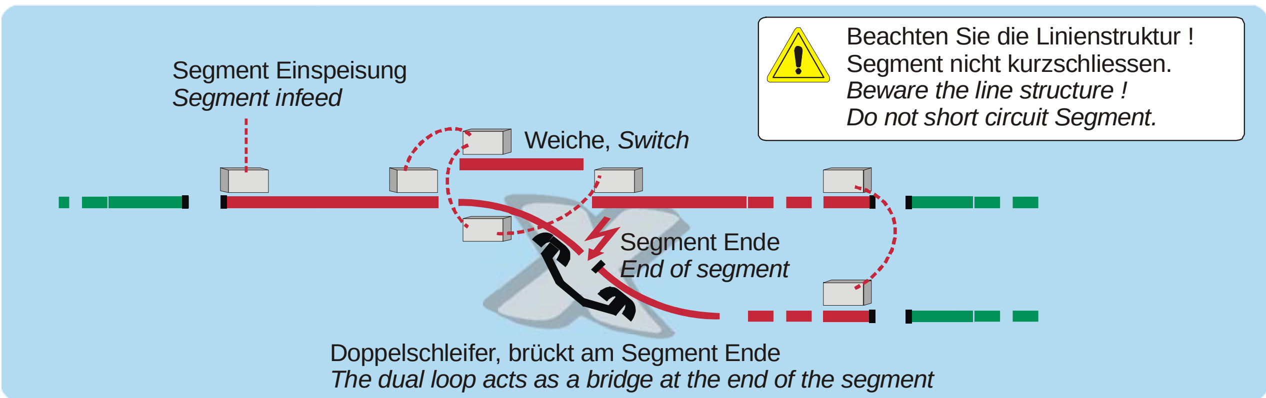
Example 2: Current collector causes a short circuit in the segment



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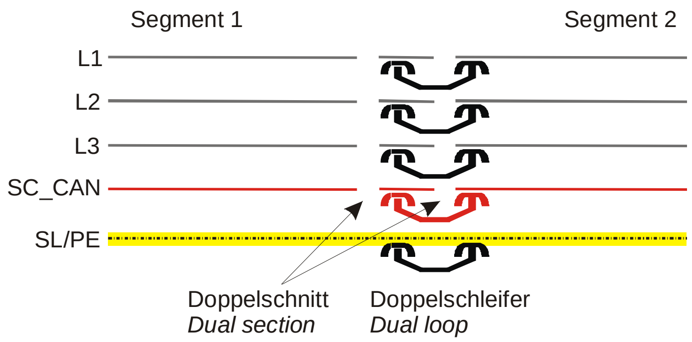
⚠ CAUTION	**There must be no voltage transfer as a result of bridging by the current collector!** Make sure no closed ring structures are created. These structures can be formed (even inadvertently) by the current collector on vehicles at switch transitions or if the physical shape of the rail path forms a circle.

Dual sections

When passing over a rail interruption separating two segments, a vehicle must not create a connection between these segments.
Where dual current collectors are employed, this can be ensured by, for example, a double rail interruption (dual section) at the segment boundary.



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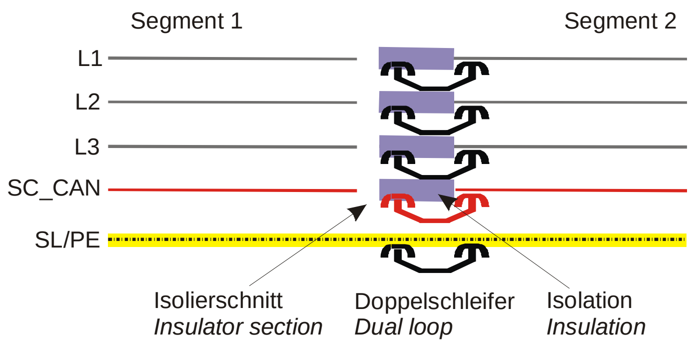
Insulated section

In place of the “dual section”, the current collectors can also be designed to be insulated (insulated section).
The insulated section can be created by, for example, installing an insulator in place of the conductor rail or by insulating the conductor rail with a suitable insulator. Aside from the insulator’s specific insulation properties, its mechanical characteristics – in particular, its wear resistance – must also be considered.



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NOTICE

The insulated section must be longer than the current collector!
In all cases, follow the instructions provided by the manufacturer of the particular rail system.

3.4.5. Verifying the Project Planning Data

The CANtrol *powertrack* segments can be designed by applying a number of performance values to a few simple rules of thumb. To do this, the following performance values must first be determined.

Installation-specific performance values	Value	Unit
Sum of all stub line lengths within the segment, without vehicle stub lines	S_{St}	[m]
Stub line length from the current collector to the vehicle controller	S_{Fz}	[m]
Maximum number of vehicles per segment	n_{Fz}	
Total number of terminal points (cable/rail transitions) within the segment	n_{Kl}	

In the next step, the theoretical maximum possible length of the CANtrol *powertrack* segment is roughly calculated.

Baud rate [Kbit/sec.]		35.7	41.6	50.0	62.5	83.3	125.0
Theoretical maximum length	S_{th} [m]	1660	1440	**1200**	940	700	----
Reduction due to stub lines	R_{St} [m]	Type T1 controller: Type T2 controller:			S_{St} * 6 S_{St} * 3		
Reduction due to terminal points	R_{KL} [m]	Type T1 controller: Type T2 controller:			n_{KL} * 10 n_{KL} * 10		
Reduction due to the no. of vehicles	R_{Fz} [m]	Type T1 controller: Type T2 controller:			n_{Fz} * 6 * (S_{Fz} + 0.2) n_{Fz} * 3 * (S_{Fz} + 0.2)		
Theoretical segment length	S_{Seg} [m]	$S_{Seg} = S_{th} - R_{St} - \mathbf{R_{KL} - R_{Fz}}$					

⚠ CAUTION

The individual calculations offer merely approximate values and can only be used to roughly estimate the segment lengths.
In borderline situations, always consult BERGHOF Automationstechnik.

ℹ NOTICE

The newest generation of *powertrack* cell controllers offers a transmission pulse strength which lies between the values for T1 and T2.
This means that, at 50 Kbit/sec., these cell controllers correspond to the maximum performance parameters of both T1 as well as T2. This also ensures that these devices will communicate at 50 Kbit/sec. with devices having T1 or T2 performance characteristics. New installations are designed to operate exclusively at 50 Kbit/sec.

ℹ NOTICE

A data rate 50 Kbit/sec. should be used for all new applications. This rate offers the best compromise between data transmission speed and segment length.
The latest generation of *powertrack* cell controllers has been optimized for 50 Kbit/sec.

Example 1 : **Type T1 controller; baud rate = 50 Kbit/s; planned segment length = 300 m**

Determined performance values:

- Sum of all stub line lengths within the segment, without vehicle stub lines — S_{St} 60 m
- Stub line length from the current collector to the vehicle controller — S_{Fz} 2 m
- Maximum number of vehicles per segment — n_{Fz} 30
- Total number of terminal points (cable/rail transitions) within the segment — n_{Kl} 25

Estimated maximum length:

S_{Seg} = 1200 - 60 * 6 - 30 * 6 * (2 + 0.2) - 25 * 6 = 294 m

☹ The calculated segment length, S_{Seg}, is shorter than the planned segment length. Layout **NOT** permissible!

Possible solution: Use a Type 2 controller

S_{Seg} = 1200 - 60 * 3 - 30 * 3 * (2 + 0.2) - 25 * 3 = 747 m

☺ Permissible layout!

Example 2 : **Type T1 controller; baud rate = 83.3 Kbit/s; planned segment length = 250 m**

Determined performance values:

- Sum of all stub line lengths within the segment, without vehicle stub lines — S_{St} 25 m
- Stub line length from the current collector to the vehicle controller — S_{Fz} 1 m
- Maximum number of vehicles per segment — n_{Fz} 30
- Total number of terminal points (cable/rail transitions) within the segment — n_{Kl} 20

Estimated maximum length:

S_{Seg} = 700 - 25 * 6 - 30 * 6 * (1 + 0.2) - 20 * 6 = 220 m

☹ The calculated segment length, S_{Seg}, is shorter than the planned segment length. Layout **NOT** permissible!

Possible solution: Shorten the vehicle stub line to 0.5 m

S_{Seg} = 700 - 25 * 6 - 30 * 6 * (0,5 + 0.2) - 20 * 6 = 304 m

☺ Permissible layout!

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4. Configuring the Controllers in a Segment

Configuration is performed with CNW. A hierarchical network contains three classes of controllers:

1.) High level: CAN/Ethernet gateway;

2.) Mid level: Segment controllers;

3.) Low level: Vehicle controllers.

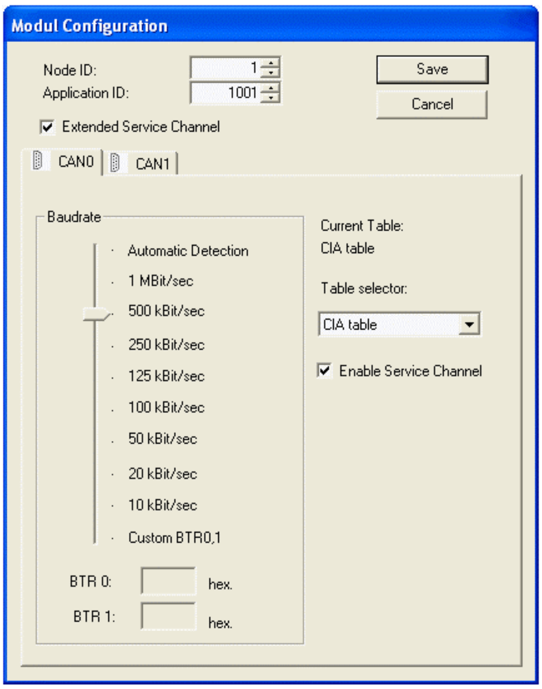
The configurations described below employ the application ID to identify the controllers.

NOTICE	**The values for the transmission rates of the standard CAN busses are taken from the CiA table.** These are default settings recommended by the CAN in Automation user association. The contact line table (rail bus table) is only used where a controller has direct access to an installation with a contact line.

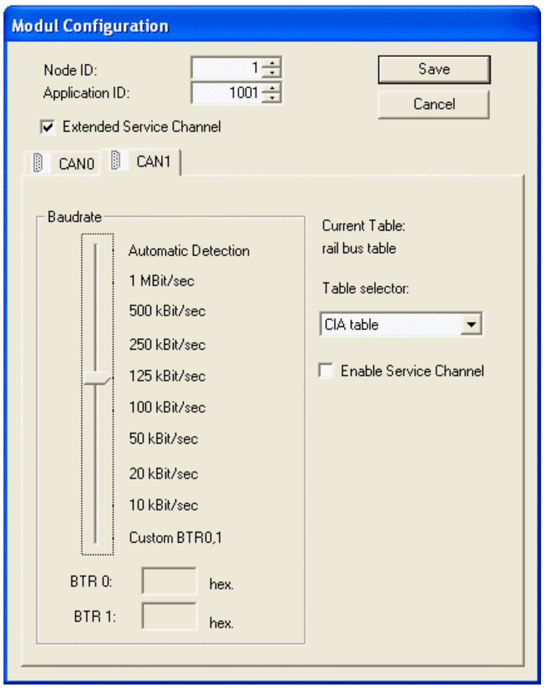
4.1. CAN/Ethernet Gateway Controller

The figure below illustrates the configuration of a CAN/Ethernet gateway controller. The settings for CAN0 are shown on the left, while those for CAN1 are shown on the right. The gateway controller uses CAN0 to communicate with the segment controller. In this example, a transmission rate of 500 Kbit/sec. has been selected from the CiA table (table for standard CAN). The "Release Service Channel" checkbox is only activated for CAN0. This allows the CAN telegrams exchanged between the tools (CP1131 / CNW) and the controllers to pass unhindered. 125 Kbit/sec. (CiA table) have been selected for CAN1. This is the maximum permissible transmission rate for this CAN bus.

CAN0 and CAN1 configuration at the CAN/Ethernet gateway controller



2VF100221DG01_en.gif



2VF100222DG01_en.gif

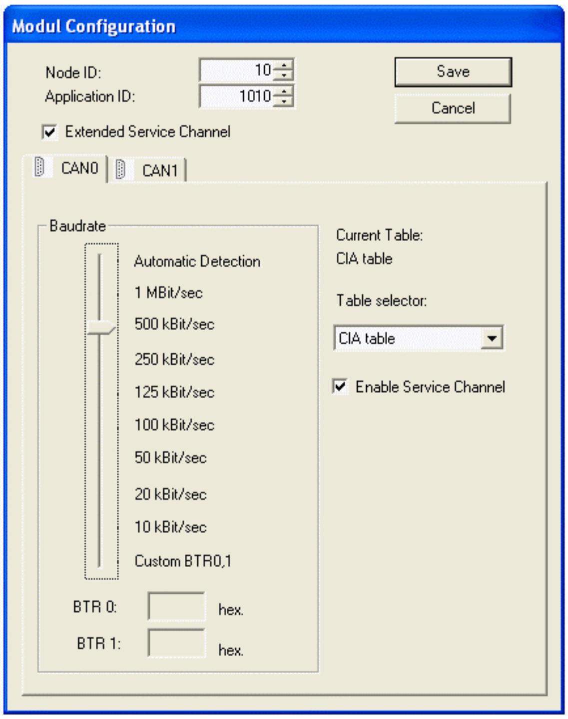
4.2. Segment Controllers

The figure below illustrates the configuration of a segment controller. The settings for CAN0 are shown on the left, while those for CAN1 are shown on the right. 50 Kbit/sec. have been selected for CAN1 (rail bus table). This is the same transmission rate set for CAN1 on the vehicle controller.

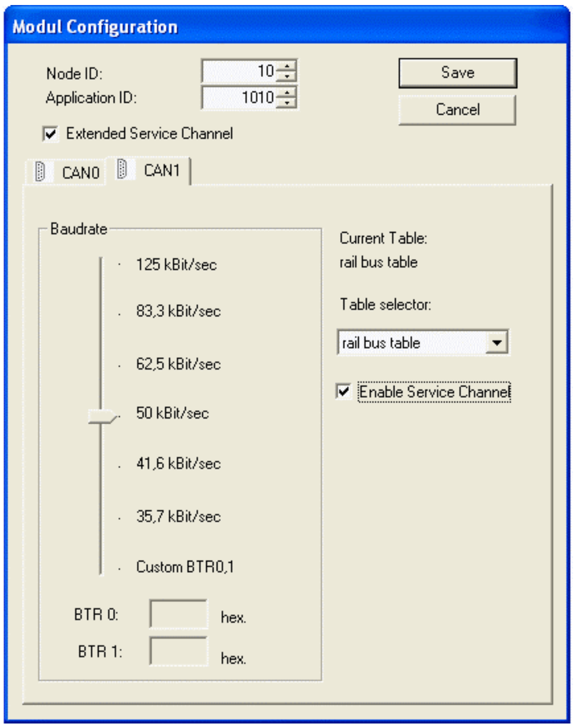
The segment controller uses CAN0 to communicate with the CAN/Ethernet gateway controller. In this example, a transmission rate of 500 Kbit/sec. has been selected from the CiA table (table for standard CAN).

The “Release Service Channel” checkbox has been activated for both CAN0 and CAN1. This allows CAN telegrams received from the tools (CP1131/CNW) and sent to the vehicle controllers to be forwarded.

CAN0 and CAN1 configuration at the segment controller



2VF100223DG01_en.gif



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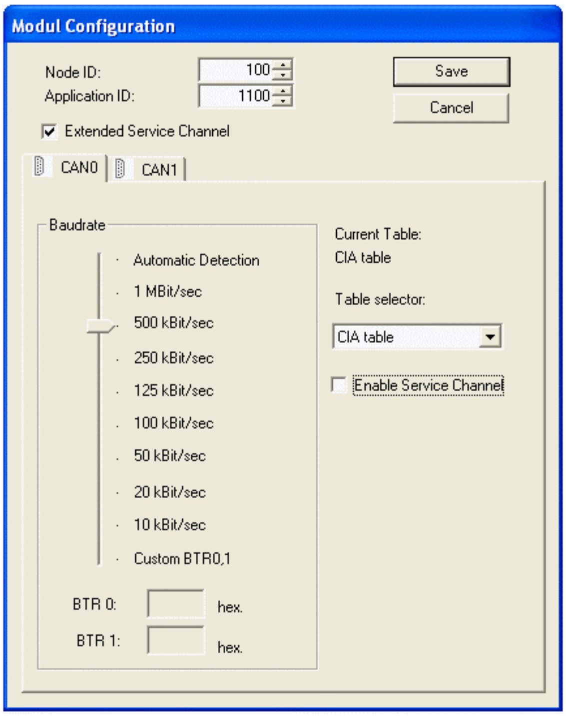
4.3. Vehicle Controllers

The figure below illustrates the configuration of a vehicle controller. The settings for CAN0 are shown on the left, while those for CAN1 are shown on the right. 50 Kbit/sec. have been selected for CAN1 (rail bus table). This is the same transmission rate set for CAN1 on the segment controller.

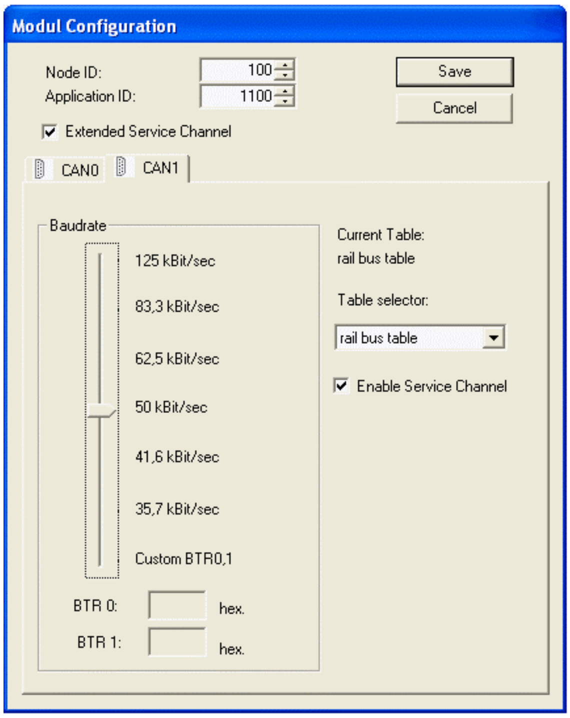
The vehicle controller uses CAN0 to communicate with the local CAN components, e.g., a drive controller. In this example, a transmission rate of 500 Kbit/sec. has been selected from the CiA table (table for standard CAN).

The "Release Service Channel" checkbox is only activated for CAN1. This prevents CAN telegrams received from the tools (CP1131/CNW) and sent to the vehicle controllers from reaching the drive controllers, allowing communications errors and performance problems can be avoided.

CAN0 and CAN1 configuration at the vehicle controller



2VF100225DG01_en.gif



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5. Checking the SC_CAN Installation

During the course of practical employment, various problem sources have been found to represent possible causes of faults:

- Incorrect installation parameter dimensioning, e.g., segments which are too long or too many vehicles in a given segment. The “Installation Layout” sections contains detailed information in this regard.
- Installation errors, e.g., no continuous signal line or return conductor (protective ground) connection or reversed connections (short circuit).
- One or more communication components no longer function during operation.

5.1. Detecting Installation Errors

Aside from a step-by-step commissioning, a careful examination of all connections is the most highly recommended way in which to detect installation errors.

5.1.1. Examining the Equipment Installation

NOTICE

The use of the wrong instruments will frequently result in a failure to detect short circuits which are easily possible between two lines.

To improve inspection tasks, there should be no vehicles in the segment being examined.

- Any one of a number of well-known, high-ohm continuity testers (e.g., Duspol) can be employed as a measurement and test instrument. However, using a +24V control voltage and a +24V test lamp is more reliable.
  On the other hand, it should be noted that simple multimeters in particular can produce incorrect measurements since the presence of induced 50 Hz currents and / or other interfering foreign influences can always be anticipated in installations.
- We can also recommend separately measuring the loop resistance (using a suitable instrument) for each return conductor. The anticipated result values can be estimated from the length of the loop and the known, specific cable resistances and, under normal circumstances, are less than 10 W.
- The result of a test measurement with both return conductors (with a bridge installed at the distant end and the RC section bridged for the measurement) will produce a value which is roughly 2/3 of that obtained from the measurement of only a single return conductor.

5.1.2. Examining the Vehicle Installation

Aside from the data transmission requirements, the requirements of other systems must also be taken into consideration during the design and execution of the vehicle wiring. For example, improper cable layout can result in other systems being adversely affected.

- Compliance with wiring specifications intended to ensure decoupling can only be checked by visual inspection.
- Vehicles must be inspected for proper wiring in their fully installed state. For this examination, all possible sources of faults and errors must be inspected, for example, any connections which could be reversed or anything which might not be properly attached or crimped.

Loose connections

Contact faults such as a loose return conductor connection on a vehicle are difficult to trace if they were not detected during a visual inspection. For this reason, we recommend the use of a CAN bus analysis tool capable of indicating CAN error frames.
Error frames show communications errors which occur during CAN data transmission and which are a normal feature in installations where vehicles constantly move from one segment to another. However, where a loose connection exists, the number of error frames is significantly greater and can reach levels at which communications within a system will briefly stop or even be totally impossible.

In order to narrow the search for the location of the error it is important to observe whether the error frames only occur in a specific segment. If so, the installation of this segment must be reexamined. If the error frames travel from segment to segment with a single vehicle, this vehicle must be identified and inspected accordingly.

ℹ NOTICE	**Appropriately designed CAN application software installed on the vehicles and the system controllers can also offer an additional diagnostic aid.** Using the ECAN_STATE functional module of ECAN.LIB (refer to the “Functional Modules” manual), the installation programmer can identify communications errors and establish their spatial and positional relationship (provided the appropriate measuring systems are available).

5.2. Detecting Faulty Communications Components During Operation

In an operating communications system, contact line components and the controllers are particularly prone to failure. Faulty controllers should be able to be identified with a relatively high degree of assurance by means of suitable measures in the installation software, e.g., regular monitoring telegrams. Errors resulting from defects in the contact line system are more difficult to detect.

NOTICE

In this regard, all maintenance and service instructions provided by the contact line component manufacturers and detailed in the associated manuals must be observed.

The following describes the two most common error sources in a contact line system. Configurations and combinations other than these are certainly possible which is why the following is intended merely as an aid and makes no claims to being comprehensive:

Carbon breaks

Despite regular maintenance, contact problems with the carbon contacts can arise. The effects can range from intermittent contact loss to complete failure. The difficulty in this case lies in the fact that the faults are similar to other errors. Intermittent contact problems appear the same as loose connections in the vehicle installation. A total loss of communications can also be the result of a defective controller. However, since problems with the carbon contacts are the most likely cause of failures, these should be inspected first and be replaced as required. Only then should the wiring and the controller be examined.

Short circuits

Another possible fault is that the contact no longer threads into the correct contact line at the contact line transition points, e.g., at segment boundaries or switches This can result in problems on the supply line, but equally, in communications problems.
If a sudden partial or complete failure of communications segments occurs during operation, all contact lines should be inspected to be sure they are being correctly guided.

NOTICE

Incorrect threading can also occur in installations or contact line transitions which have functioned for years without any signs of suffering from this problem!

5.3. Contactless Communications

In order to avoid these known problems with contact lines, BERGHOF Automationstechnik has developed a system for contactless CAN communications. Please call us if you are interested in further information about this system.

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6. Annex

6.1. Environmental Protection

6.1.1. Emission

When used correctly, our modules do not produce any harmful emissions.

6.1.2. Disposal

At the end of their service life, modules may be returned to the manufacturer against payment of an all-inclusive charge to cover costs. The manufacturer will then arrange for the modules to be recycled.

6.2. Maintenance/Upkeep

⚠ WARNING	**Do not insert, apply, detach or touch connections while in operation – risk of destruction or malfunction.** Disconnect all incoming power supplies before working on our modules; this also applies to connected peripheral equipment such as externally powered sensors, programming devices, etc. All ventilation openings must always be kept free of any obstruction.

The modules are maintenance-free when used correctly.
Clean only with a dry, non-fluffing cloth.
Do not use detergents.

6.3. Repairs/Service

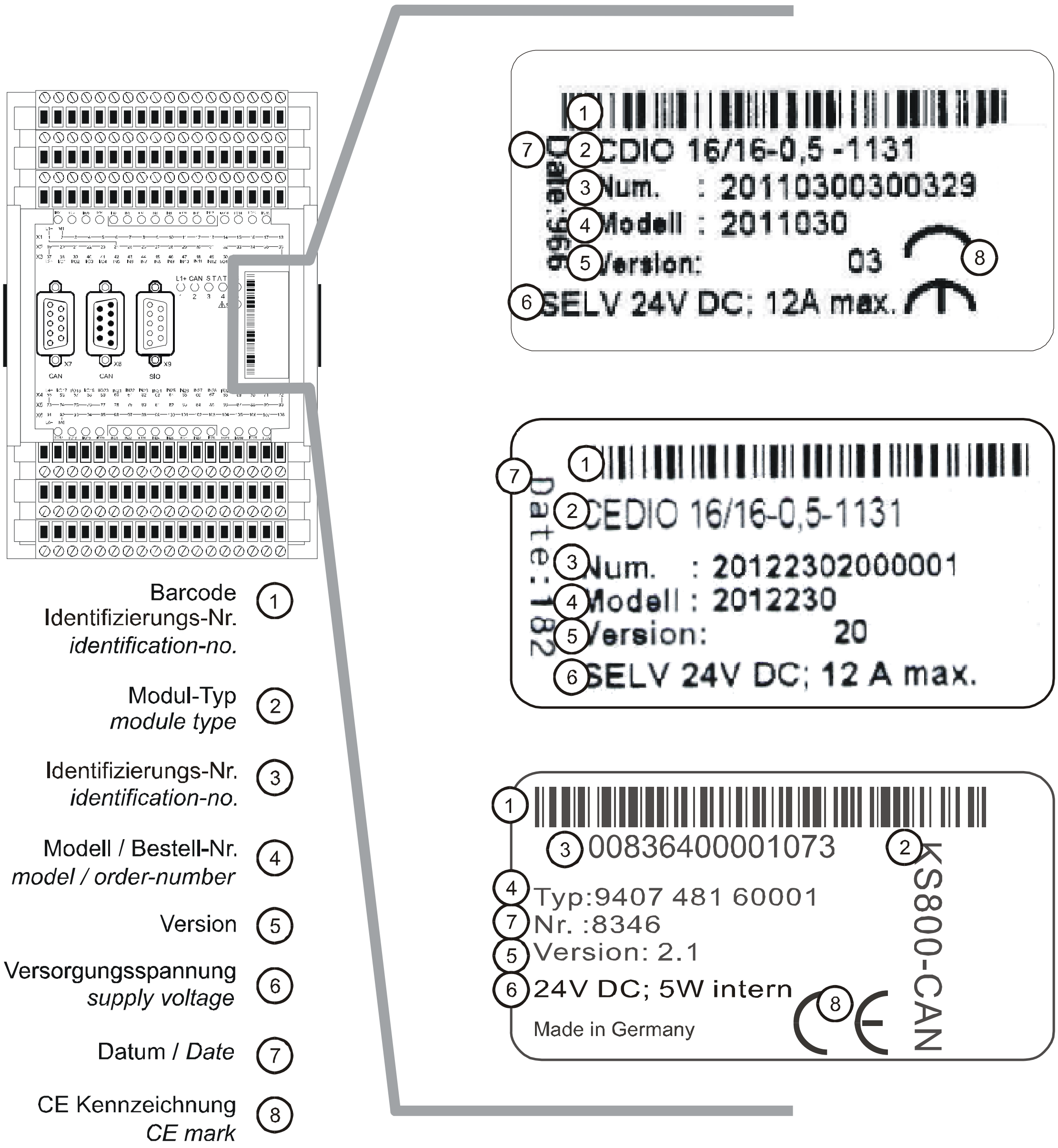
⚠ WARNING	Repair work may only be carried out by the manufacturer or its authorised service engineers.

6.3.1. Warranty

Sold under statutory warranty conditions. Warranty lapses in the event of unauthorised attempts to repair the equipment and/or product, or in the event of any other form of intervention.

6.4. Nameplate

Erklärungen zu den Typenschildern (Beispiel)
nameplate descriptions (example)



2VF100080DG01.cdr

① **Barcode**
same as identification number.

② **Module type**
plain-text name of module.

③ **Identification no.**
module's identification number.

④ **Model/order no.**
You only need to give this number when ordering a module. The module will be supplied in its current hardware and software version.

⑤ **Version**
defines the design-level of the module as supplied ex-works.

⑥ **Supply voltage**

⑦ **Date**
internal code.

⑧ **CE mark**

NOTICE	**The 'Version' (supply version) panel specifies the design-level of the module as supplied ex-works.** When replacing a module, users, with the CNW (CANtrol Node Wizard) tool, can read off the current software version of the newly supplied module, and then reload their 'own' software version for a particular project if necessary. With the latter in mind, before the download you should always keep a record of the existing software levels in your project documentation (software version, node IDs, baud rate, etc.).

6.5. Addresses and Bibliography

6.5.1. Addresses

CiA	'CAN in Automation', international manufacturers and users organisation for CAN users in the field of automation: CiA - CAN in Automation e.V. Am Weichselgarten 26 D-91058 Erlangen /Germany e-mail: headquarters@can-cia.de http://www.can-cia.de		
DIN-EN Standards	Beuth Verlag GmbH 10772 Berlin	or	VDE-Verlag GmbH 10625 Berlin
IEC Standards	VDE Verlag GmbH 10625 Berlin	or	Internet search http://www.iec.ch/

6.5.2. Standards/Bibliography

IEC61131-1/EN61131-1	Programmable controllers Part 1: General information
IEC61131-2/EN61131-2	Programmable controllers Part 2: Equipment requirements and tests
IEC61131-3/EN61131-3	Programmable controllers Part 3: Programming languages
IEC61131-4/EN61131Bl1	Programmable logic controllers Supplementary Sheet 1: User guidelines
EN 50081 Parts 1+2	German EMC Act: Emitted interference
EN 50082 Parts 1+2	German EMC Act: Noise immunity
ISO/DIS 11898	Draft International Standard: Road vehicles **-** Interchange of digital information **-** **C**ontroller **A**rea **N**etwork (CAN) for high-speed communication
EN 954-1	Safety of machinery: Safety-related parts of control systems (Part 1)
Bibliography	A variety of specialist publications on the CANbus is available from specialist bookshops, or can be obtained through the CiA users' organisation.

NOTICE	Our Technical Support team will be glad to provide other literature references on request.