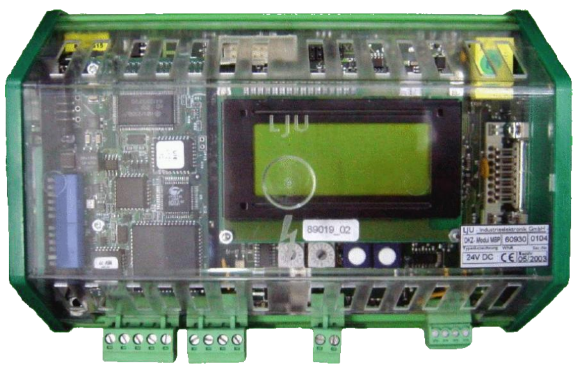
System description

Automatisierungstechnik GmbH

Decentralized
Bus Master Systems
with own intelligence

for Rail bus and
Inductive wire bus systems



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GRENZEBACH
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1 General

Constantly rising demands in the industry necessitate new individual, adaptable and independent working solutions for Automation and Control.
LJU Automatisierungstechnik GmbH presents a powerful, flexible system for these demands to the control and administration of conveyors. The decentralized Bus Master system with own intelligence.
This documentation comprises a description of the intelligent LJU Bus Master System for the control and administration of EHB (Monorail) and ground conveyors utilizing data conductors with rails (SB) or inductive wire bus (iDB).

1.1 Abbreviations

DKZ	Data Concentrator
EMS	Electric Monorail System
FTS	Floor Transportation System
Fz	Trolley
iDB	Inductive wire bus
IKB	Internal communication bus
PDE	Positioning and Data Unit (PLA integrated with inductive data transfer)
PLA	Positioning Code Light Barrier
PLC	Installation control
PM	Power module
SB	Rail bus
Sync-bit	Synchronization bit

1.2 Concepts

Code rail	Binary encoded rail for position regulation in the installation by means of PLA
Coupling	Transition from DKZ areas
Data concentrator	Interface between PLC, vehicle controls and power modules. It administers part of an installation or DKZ area
Data loop	Closed network for inductive data transfer of a DKZ area.
IKB module	Hardware component that communicates with other modules, for the administering DKZ of the installation
Installation table	Configuration of individual DKZ-areas (rail segments), power modules, couplings, Routing points etc.
Internal Communication bus	Connection between Data concentrator and IKB modules
Own intelligence	Independent control of an installation area, without additional PLC control
Parameter console	Computers or HMI on which the DKZ-Parameter software is downloaded and that communicates with the DKZ
Positioning Code Light Barrier	Reads the absolute position of the trolley in the DKZ area via scanning of the layout's coded rails (PLA or PDE)

Power loop	Constant power supply line that inductively transmits energy to the trolley
Power module	VDLs, track switches, tift tables etc.
Power pickup	Inductive pickup located on the trolley
Rail bus (SB)	The data transfer to the vehicles takes place over slide-contacts
Routing point	Points in the installation necessary for the PLC to parameterize the routing table
Routing table	Downloaded from the PLC or manually, pre-determines the way the vehicles maneuver in the installation
Segment	Routes and power modules become individual sections of the installation, for example, release and control segments for power modules, driving segments, positioning segments etc.
Separation block	Security zone in which power is switched off to prevent inadvertent admission of a trolley into the protected zone
Teach mode	Storing manually adjusted attitudes, eg. work heights from trolley lifts. Teaching one trolley at one station will subsequently alter all work heights in the other trolleys for the same station.
Wire bus (iDB)	Data transfer method to the vehicles takes place inductively over the data loop

2 System description

2.1 Overview

Conventional systems in Automation utilize complete control via PLC. Decentralized Bus Master Systems provide a means to unburden the PLC and parts of an installation completely (aside from error reporting).
An installation is divided into individual parts that constantly communicate among each other and, when enabled, with the installation PLC. After division of an entire installation into these data sections - The data concentrators (DKZ) control and administer the individual installation areas. These areas can vary in size according to the selected system and form the supporting limb between vehicle control, DKZ area and installation control. A data concentrator therefore takes over the entire control of an installation part.

All information of a DKZ area like positions, routing points, power module configurations etc. become a stored installation table in the DKZ. These tables are completely able to be modified and provide a easy way to configure the routing through an installation area.
A trolley is guided through the area completely and independently without the need of PLC logic, proximity sensors and all its associated wiring. Control of power modules (i.e. from track switches, lifters etc.), status of trolleys, and even the coordination of separation zones is also handled by the DKZ.

The trolleys within a DKZ area do not communicate among each other but only with the DKZ. It refers all information, that the vehicle requires. The DKZ takes over the distance supervision as well as the calculation of the gap distance of the trolley. In this manner, anti-collision sensors on the trolley become redundant. The current position of each trolley in the area is registered at the DKZ and is updated constantly. This is accomplished in part by the use of a PLA or PDE on every trolley and absolute coded rail through-out the system. At control area transfers (couplings), the trolley drives into a neighboring DKZ area over a predetermined span and its status and routing are registered for the new area and deleted from the old.

The data and power transfer to the trolleys for an installation are presented by two different types. The one "Rail bus" (SB) is more conventional and deals with the usage of sliding contacts and installed conductor rails. This system however still relies on the mechanical maintenance against wear. The other (iDB) is the inductive transfer of energy and data from a closed loop installation. This inductive or "wire bus" system features no moving parts for the data or power collection and performance as such would never degrade. Both systems, however, function exceptionally with the Bus Master control. This is an excellent simple solution, for example, to realize a decking operation between an EMS with sliding contacts and an inductive ground transportation system.

Another advantage over conventional installations is the "control unity" of the distributed Data Concentrators throughout the installation. Each data concentrator can be installed directly in its control area. This can provide not only one area but also all installation-relevant information about the diagnosis and control.

The Bus Master systems provide a modular and cost effective way to control large installations. Costs are saved with the elimination of numerous redundant sensors and their associated wiring. Furthermore, compatibility with standardized field- bus systems like Profibus or Modbus provide for uncomplicated connections to many different automation controls.

Consequently, the modular design guarantees a flexible system suitable for all applications.

2.2 Hardware differences SB/iDB

The control of both bus systems is based on the same principle. They differ merely in the way that power, data, and position are physically transferred and the hardware associated with it.

Rail bus:

- **Power transfer** to the trolley
  - § over rail/sliding contacts
  - § constant voltage (network-dependent)
- **Data transfer** to the trolley
  - § over rail/sliding contacts
  - § rail bus modem
- **Position reading**
  - § Positioning Code Light Barrier PLA-14
  - § PLA-14 code rails

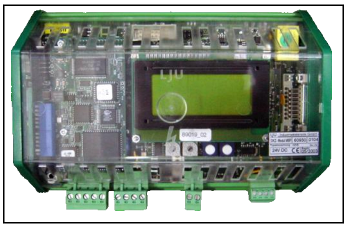
Inductive wire bus:

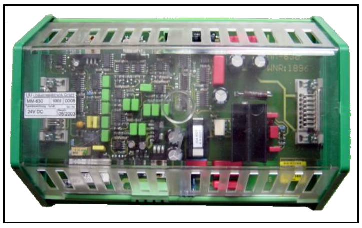
- **Power transfer** to the trolley
  - § over inductive power loop/power pickup
  - § Constant current 50A…100A/20kHz
- **Data transfer** to the trolley
  - § over inductive data loop/PDE
  - § wire bus modem
- **Position reading**
  - § Positioning Code Light Barrier PLA-112 (integrated in PDE-112)
  - § PLA-112 code rails

3 System qualities

3.1 System components

A DKZ consists of different components that are summarized to a control unit according to layout requirements.
The individual modules plug together and simply mount and on DIN-standard terminal rails. A DKZ consists of a selected field bus standard model of the data concentrator module with at least one modem module and the required IKB modules.





Data concentrator module **Modem module** (Illustration shows iDB modem) **IKB module**

3.1.1 Data concentrator module

The data concentrators are the most important units of a Decentralized Bus Master System. They independently control parts of an installation and the situated power modules included in it. It provides all necessary information to and from the vehicles in its area.

The data concentrator module displays to the operator all area-relevant information over an LCD screen and a simple menu control (see manual "data concentrator") and allows a system-near diagnosis and manual intervention into the control course through the decentralized attachment.

Data concentrators are addressed by two Hex-switches and allow up to 75 DKZ's in an entire installation.

3.1.2 Modem module

The modem module is the connective element between Data concentrator and LJU trolley controller. It conveys to the trolley all relevant information. The data is broadcasted inductively or conducted over sliding contacts, depending on the system employed.

3.1.3 IKB module

IKB modules or internal communication bus modules, forms the connecting arm of the individual DKZ areas among each other. Neighboring DKZ communicate through them over a direct data line to each other. Connecting to external devices (e.g. control panels) takes place over the furthest of the group connected using reserved addresses 2 and 3.

The IKB modules that are responsible for the data exchange between the DKZs, become internal, from address 4, over the DKZs addresses. The addressing technique takes place automatically in ascending sequence through the data concentrator itself. The DKZ with the highest address puts the master on that location. This is shown by a changing display in the IKBs.

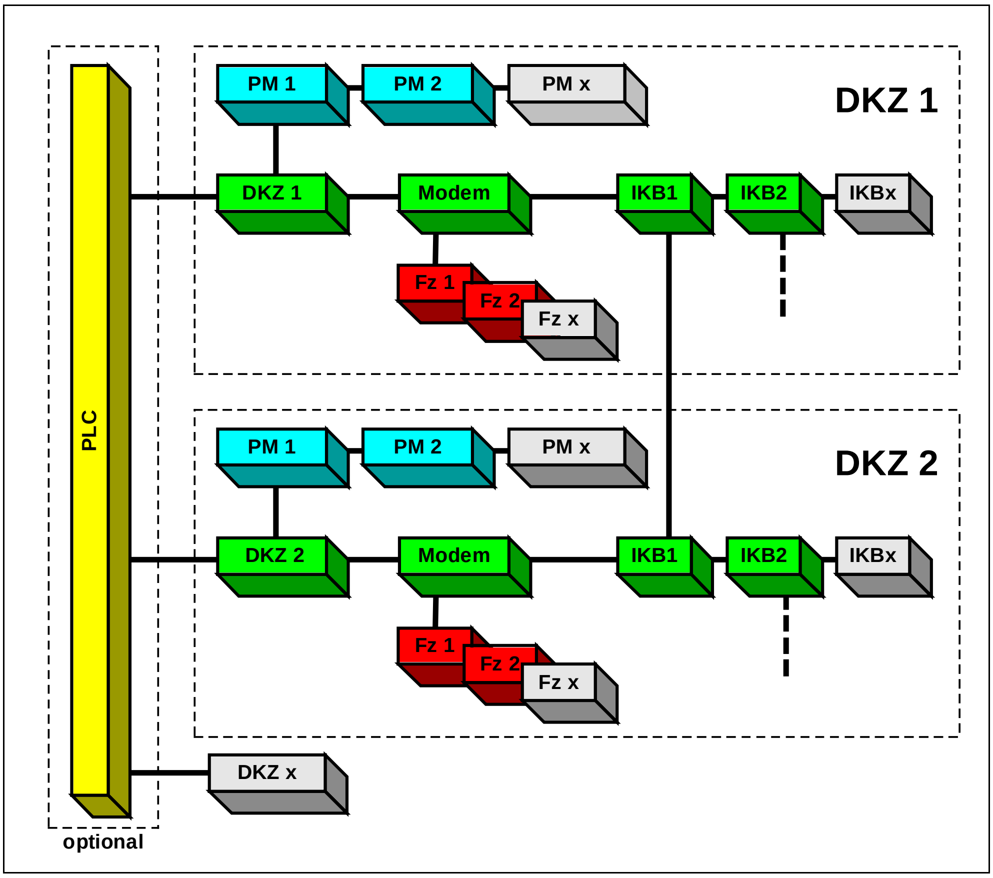
Example:

DKZ area 56 (Master):	Address of DKZ: 38 hex
Neighbor DKZ area 46 (Slave):	Address of DKZ: 2E hex
IKB in DKZ 56:	IKB address: 4
IKB in DKZ 46:	IKB address: 7

changing display IKB in DKZ 56:
M:2E → **AD:4** → **M:2E** → **...**

changing display IKB in DKZ 46:
S:38 → **AD:7** → **S:38** → **...**

3.1.4 Connection of the individual modules



3.2 Bus systems and communication

3.2.1 Available bus systems

PLC - Data concentrator:	
Modbus-Plus	Utilizing a Modbus Plus interface, the data concentrators function as Modbus Plus slaves (address 10.. 39) and the data transfer originates from the Modbus Plus master (PLC). The data traffic from the Modbus Plus field-bus is handled by a separate module (AnyBus) inserted into the DKZ housing. *Manufacturer*: HMS Industrial Networks AB, Halmstad, Sweden. The cyclic exchange of the data by this module is monitored by the DKZ.
DeviceNet	Utilizing a DeviceNet field bus, the data concentrators function as DeviceNet-Slaves (address 1.. 63). The data transfer from the master PLC is handled as cyclic data and is accessed by the DKZ via explicit messaging. The data security is monitored by the DKZ by means of a data index table.
Profibus DPV1	When the DKZ is interfaced using a Profibus DPV1 protocol, the protocol follows that of the SPC3- ASIC from Siemens AG. The DKZ functions as a Profibus DPV1slave (addresses 1..127). The data exchange follows that of the layout architecture that is configured in the Profibus-Master. A monitoring of the cyclic data occurs through DKZ.
Note! More field bus interfaces available by request.	

Daten concentrator - trolley controller	
Railbus (SB)	LJU-Bus data transfer rate: 46,875kBit/s
iDB	LJU-Bus data transfer rate: 31,25kBit/s

Data concentrator - power module
RS-485 LJU Power module bus (LJU-Bus-protocol)

Data concentrator - IKB module
RS-485 internal communication bus (LJU-Bus-protocol)

Connection IKB - IKB
PointToPoint: the data is transferred over a direct wire connection (RS-485-Interface)

3.2.2 Bus communication of the modules

The data flow of the components among each is over LJU-internal as well as standardized Bus connections.

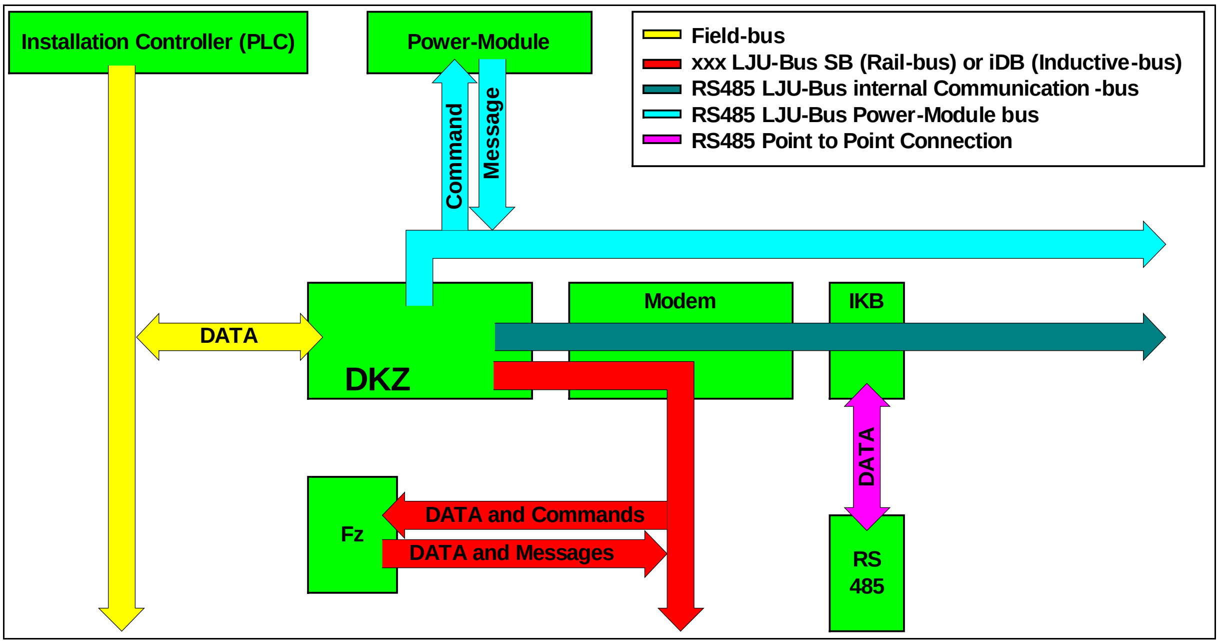


illustration shows the data exchange over the different utilized bus systems

3.3 Code rails and position reading

3.3.1 Differences SB/iDB

Depending on system, Rail bus or Wire bus systems, use different code rails for the positioning.

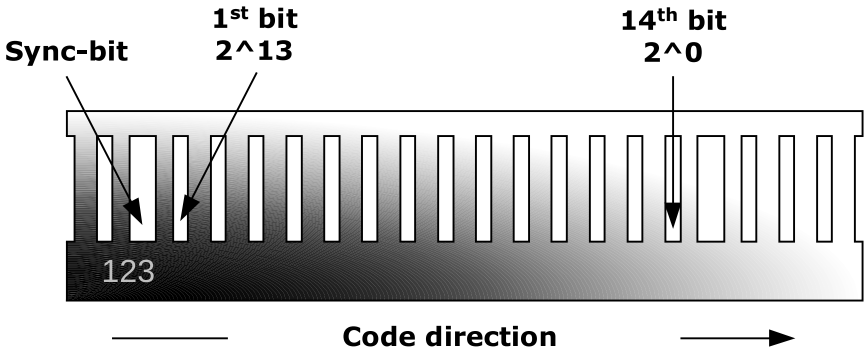
Rail bus: PLA-14 code rails
iDB: PLA-112 code rails

While code rails serve only the position regulation for the Rail bus system, code rails of the inductive system used to hold the conductors for the data and power loops.

Another difference consists of the encoding of the rails. Code rails of the conventional system encode binary with 14 bits, that of the inductive system is with 12 bits encoded. However, the position reading principles are the same (PLA-14 with Rail bus, PLA-112 with Wire bus). By sensing of the individual codes in the rails with help of photo-arrays the positioning with millimeter-accuracy is achieved. Every code in the code rail begins with a synchronization bit, whose slit is wider as that belonging to the following. Open slits are interpreted as “1”. A code follows from this “Sync-bit” with 14 or 12 consequently slits to form the positions code.

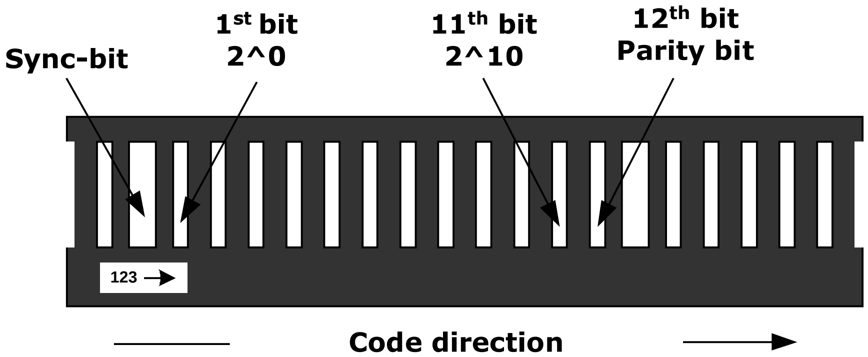
Note!
In contrast to the PLA-14, with which all 14 bits serve as position encoding. The code of the PLA-112 is completed by a parity bit (odd parity), this effectively codes the position over 11 bits.
Another difference consists that with the PLA-14 the most significant, bit follows the Sync-bit. With PLA-112 the Sync-bit is followed by the least significant bit.

3.3.2 Code rails PLA-14



Codes per rail	7
Length of a position encoding incl. Sync-bit	128mm
maximum number of different code rails	2340
Maximum code-able route without code repetition	2096m
Code rail length	896mm

3.3.3 Code rails PLA-112



Codes per rail	7
Length of a position encoding incl. Sync-bit	96,5mm
maximum number of different code rails	292
Maximum code-able route without code repetition	198 m
Code rail length	675,5mm

3.4 Data loop/Data bus

The data bus of a DKZ area (data loop) is laid parallel to the transport route and is meant for the transmission of data from the DKZ module to the trolley. Data is exchanged between the DKZ and the trolley controller via a master modem.
The data transmission is carried out conventionally depending on the system used, i.e. the data bus is installed in the slide contact rails and connected to the trolley through loops or connected inductively in the floor transportation systems and in the inductive electrified monorail systems (EHB-systems), i.e. the data loop consisting of symmetric two-wire cable lines is laid parallel to the power loop and the data transmission to the trolley takes place via inductive send and receipt units.

3.4.1 General guidelines for iDB and SB

1. The data and power loop areas should have the same coverage. Multiple data loops within one power loop area are possible without any problems. However, if a data loop is laid across multiple power loop areas, then every power supply module of an area picks up interfering signals that may lead to communication errors and therefore this constellation is to be avoided.

2. Only shielded and twisted data cables are to be used as data feeder cables, leads and bridges. The shield of the feeder cables is to be connected on one side at the data concentrator with the PE.

3. The data line is laid as a pure linear structure, since branched-out structures can lead to mismatches and reflections and thus to more severe interferences. Unavoidable lateral branching (stub or service cables), like those in power modules, e.g. points, are to be kept as short as possible and should not exceed a length of 3 m.

4. The data loop is to be terminated with a resistance, which is connected in series at the end of the data loop.

3.4.2 Specific guidelines for SB

1. The data loop is laid only as a pure linear structure.
2. Stub lines are laid parallel to the main loop and are not terminated.
3. The data loop is terminated with a resistance of **220Ω/ 9W**.

see also chapter 4.4.1

3.4.3 Specific guidelines for inductive EMS

1. The data loop should be laid out as a linear structure.
2. Stub lines are laid in series with the main loop.
3. The data loop is terminated with a resistance of **68Ω/ 10W**.
4. The **"Y structure" in inductive systems** represents a **special case**: A parallel connection of two loop sections that are of nearly the same length at the point of data feed can be implemented. In this case, both loop ends should be terminated with a resistance of (68Ω) each.
5. A complex data loop structure can be simplified by using a double modem (one data concentrator feeds two master modems).
6. Lines of the data loop transitions from the code rail profile to other elements, e.g. terminal boxes or between the point-legs, etc. are to be twisted.

see also chapter 4.4.2

3.4.4 Specific guidelines for inductive FTS

The same guidelines applicable to inductive EHB (point 3.4.3) are applicable for the inductive floor transportation systems, but the following have to be ensured in addition:

1. The data loop is to be divided pair-wise into sections of equal length and are to be interconnected in anti-phase. Thus, interfering signals that are launched are dephased by 180° and thus they mutually cancel each other. Due to the antiphase interconnection, intersecting points occur in the data loop, at which communication is not possible. Therefore the intersections are to be executed close together (minimum 45°) and not at stop points.

2. A section of the data loop in connectable power loop sections (e.g. in lifter bars and in separating areas) has to compensate the interference voltages by itself, so that its influence on the entire data loop is independent of the connected status. The data loop is therefore to be intersected in the middle of the lifter bar or the separating area.

3. The data lines are to be twisted, if data loops have to be laid through power loops (e.g. at track switches or feeders).

4. At area transitions (change of the data concentrator area), the data loop is to be laid with a break of 50mm, in order to avoid a cross-talk of data when the trolley overshoots.

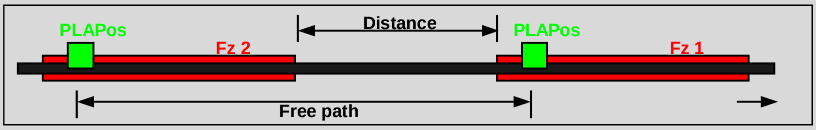
see also chapter 4.4.3

3.5 Maintaining distance and free path

Due to the uninterrupted, cyclical communication of the trolleys with the data concentrator, the Decentralized Bus Master System can monitor the free path of a trolley and thus, implement the protection against collision between the trolleys. The bus master system can perform these tasks fully independently and without additional anti-collision initiators or distance sensors.

The path of the trolley is calculated by means of the position recording wherein every single trolley transmits its position in the DKZ area to the DKZ, with an accuracy of millimeters, with the help of the laid code rails. The calculation of the free path takes place across the DKZ transitions or power modules. The distances between the trolleys can be configured separately for every segment by means of a distance table imported into the trolley and a system table configured in the DKZ.

Note!
Path calculations are based on PLA, i.e. details of the free path are valid from PLA to PLA. The trolley length and distance specifications are taken into account by the trolley itself.



For the path calculation and distance maintenance, the data concentrator maintains a constantly (cyclically, approx. every 200 ms) refreshing system map with all the relevant trolley information, including the unique, absolute positions of all the trolleys found in the area and can thus determine the distances between adjacent trolleys by a complete analysis of this data. For the next cyclical addressing of all the trolleys in the area, the data concentrator transmits to each trolley, the determined exact distance to an adjacent trolley. Every trolley reacts to it with an adjustment in speed when there is a change in the distance, which brings the trolley to a stop if the minimum distance is not maintained. Thus, protection against collision is ensured.

The determination of the exact positions is fundamental to the implementation of the protection against collision. In order to constantly ensure this, special precautions were taken for an error-free determination of position:

1. Position monitoring in the trolley

The trolley controller monitors changes in the positions transmitted by the PLA with reference to the drive command and the changes to be expected. The position provided by the PLA is taken as the actual position of the trolley only if the theoretical and determined values match. If there is no match, then a one-time faulty measurement is accepted. In this case, the theoretical position of the distance determination is taken as the base. If there is no match in the next position reading, then the trolley is stopped immediately and an error message is generated. The position is determined cyclically, in very short time intervals (approx. every 25 ms) and evaluated by the trolley controller. Since the trolley can cover only a few millimeters of distance in this short time interval, it is not risky to tolerate a one-time faulty measurement. Furthermore, like in the data concentrator also, a position-based system map is stored in tabular form in the trolley controller. Every position value is checked for correctness with the help of this table. If the position determined in the trolley is not stored in this table, then the trolley is stopped immediately and the trolley controller generates an error.

2. Monitoring by the data concentrator

Like in the trolley controller, the data concentrator verifies the position transmitted by the trolley with the help of its stored system table. Thus if a position not existing in this table is reported by a trolley, then all the trolleys in the DKZ area are stopped immediately and the protection against collision is ensured.
Another basis for the protection against collision is the error-free transmission of the positions and distances between the trolley controllers and the data concentrator. Due to this reason, all telegrams are secured by a checksum, which is based on a specially determined polynomial. Thus, transmission errors, which can occur due to the external influences, can be

detected and the resultant incorrect values can be discarded. In addition, due to a defect in the send/receipt unit of the data concentrator or the trolley controller, or due to a breakage in the data bus, the communication between them can be completely disrupted. Therefore the data concentrator acting as the master in this communication path, accepts only one unanswered telegram also. The detection of a communication failure over the period of the last received telegram takes place in the trolley itself, which acts as the slave on the communication path. The time interval between two received telegrams should not exceed double the actual bus cycle time. Whenever a communication error occurs, the trolley is stopped immediately and the corresponding error message is generated.

Through these control mechanisms, the Decentralized Bus Master System ensures that the determined position values and the distances or the free paths calculated from the same are correct; it also ensures the error-free transmission of these values. Thus the Decentralized Bus Master System ensures an assured protection against collision.

3.6 System limits

The following section gives information about the technical limits of the data concentrator, according to the selected system.

Technical limits	
max. bus length (SB) per DKZ	200m
max. bus length (SB) per DKZ *	60m
max. Number DKZ areas	75

* through technical advancements can function restrictions be extended

Limits of the data concentrator (both systems)	
max. managed power modules	10
max. managed vehicle number	30
max. possible couplings to **one** neighbor-DKZ	10
max. number possible neighbor-DKZs	10
max. possible couplings altogether	20
max. segment number/routing points	60

Note!
The manageable trolley number of a DKZ is dependent on the DKZ area and area of Power modules.
I.e. if DKZ area can fit more than the manageable number of trolleys, then the installation control must take care that not more than the allowed number of trolleys enters in the DKZ area.

$$Fz_{\max} = 30 - powermodules$$

4 System setup

> **Note!**
> The following chapters describe the setup of a Decentralized Bus Master System.
> In avoidance of mistakes, we recommend to order the engineering of the system from the LJU Automatisierungstechnik GmbH.

4.1 Divisions in DKZ areas

The basic idea of a Decentralized Bus Master System is the division of an entire installation into individually manageable parts, and to unburden the installation control (PLC or Process computers.

An installation of a DKZ can overtake the processes of switch and lift control, as well as routing as per product identification.

With the division of the areas, it must be heeded that

1. the max. Bus length cannot be exceeded!

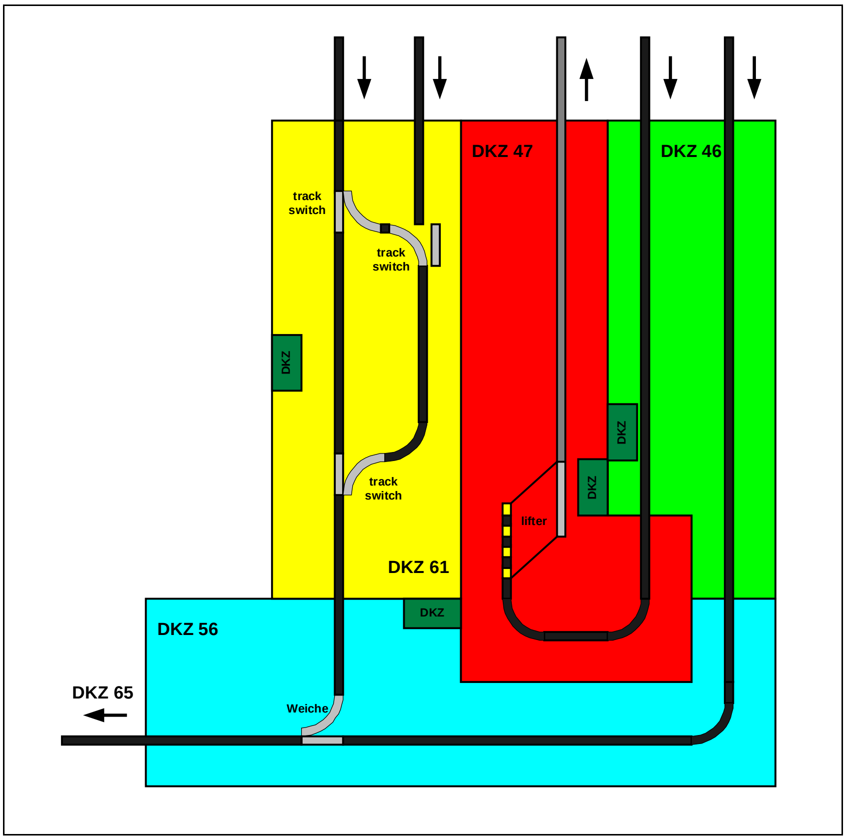
> **Attention!**
> Data loop lengths to and from the power modules and to the rail must be included.

2. if not controlled by the PLC, only the prescribed number of trolleys can come in into the area.
3. the max. power module number is not exceeded.
4. couplings are not installed in power module segments.
5. DKZ entrance segments are length of 300mm doesn’t under-drive (speed-dependent).

6. DKZ exit segments are length of "trolley length–700mm" doesn't span.

Special segment lengths!
see also chapter 4.6.2

Example for an installation excerpt and their division into DKZ areas:



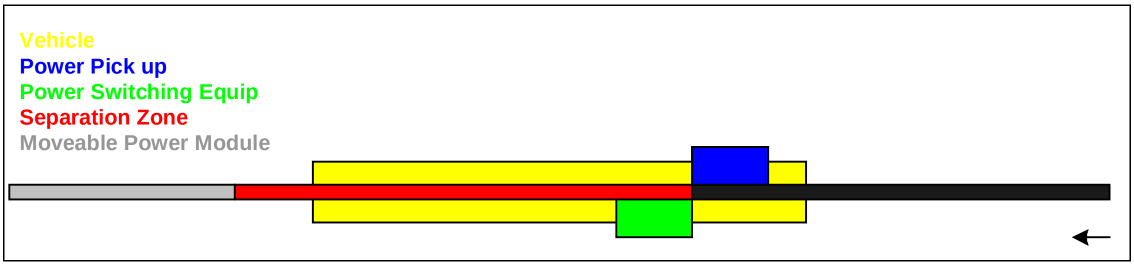
Displayed is an example of DKZ areas and their order according to the controlled area.

- the control areas and their power modules are easy to diagnose and manually control
- no couplings in the power module zones
- shortest possible routing to the power modules and from DKZ to DKZ

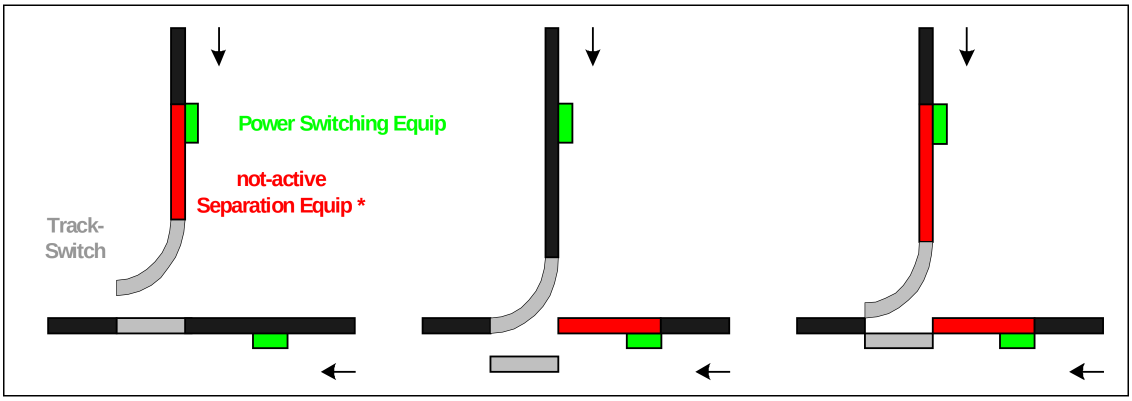
4.2 Location of separation blocks

Separation blocks are security zones for the power modules. Through shutdown of the power in these areas, false entry of trolleys into the area is prevented.
The switching of the separation blocks occurs with help of system-sensitive power switch devices and is passed directly over the power module control. The configuration takes place over the installation table of the DKZ, that mimics the commands for the power modules.
Separation blocks are installed at the entrances of the power modules. The length of the separation blocks is dependent on the position of the power pickup. The length must be chosen so that no part of the trolley enters the restricted zone after brought in the separation block with full load and speed and braked solely on having the power removed.

Establishing separation block for a vehicle
(mounting place of the power pickup is behind)



Separation area representation for track switch
(two entrances, one exit)



* not-active - Separation area power-less (fail safe)

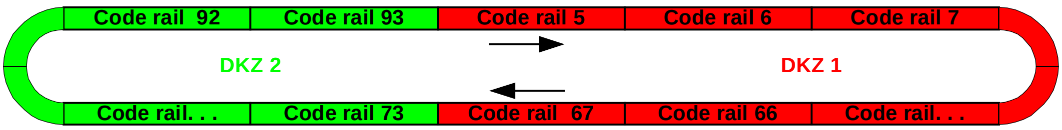
4.3 Installations of the code rails

4.3.1 General

The code rails for both systems are treated the same. The code rails are installed parallel to the main traveling direction with ascending code. For assistance, the coded rails are numbered and an arrow indicated the ascending direction.

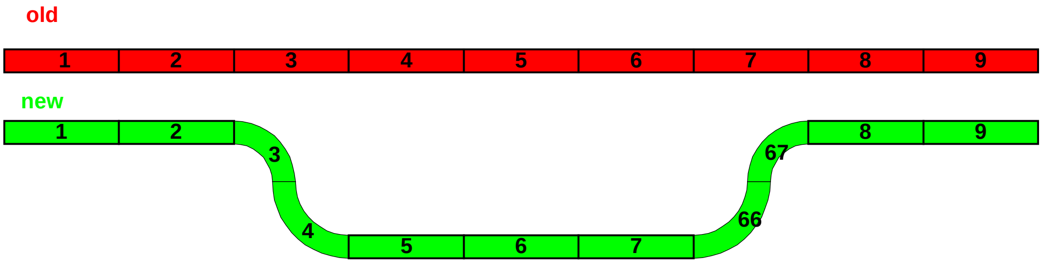
Each position is allowed to be used **in a** DKZ area only **once**. Code repetitions within an entire installation separate DKZ areas, is possible.

Normally the coded rail would be installed continuously ascending. However, through DKZ areas and other installation transfers each area should start with a reserve (numerical gap) to provide for future modification and expansion. Further exceptions (for example, the installation of the code rails within power zones) is described in the following sections.



4.3.2 Insertion of installation pieces

Every installation can experience structural alterations (eg. route changes). In order to accommodate such changes, it is not necessary to rebuild the entire DKZ area.



Additional rails can simply be added and their numbers adapted into the installation table, the area is again operational. It must be considered that rail numbers should be significantly different from that of the entire DKZ area.

4.3.3 Installation in power modules

Through the merging of routes and un-allowed code repetition in DKZ areas, it is necessarily to accommodate the code rails so that they continue in their ascending manner.

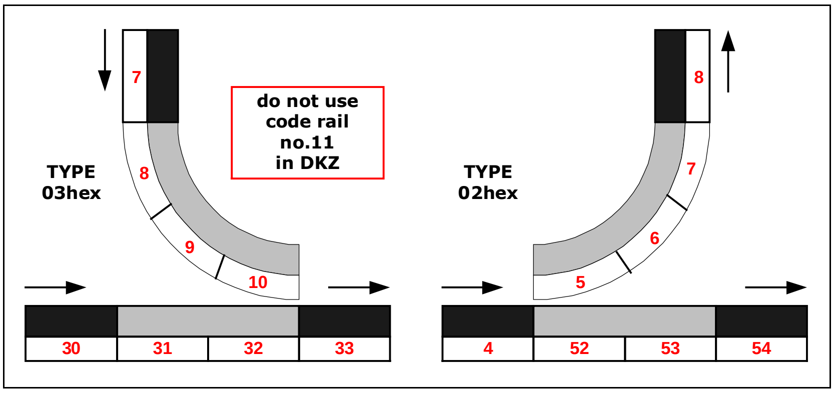
While standard lifters, like straight routes, can be looked at in as simple consecutive transferring points, a few peculiarities are to be heeded with the installation in track switches.

Generally, the installation of the code rails is ordered as power module dependant, that is specific to the identity of the respective Power module.

In the following examples is are standard track-switches of the types:

03hex	two entrances, one exit, nonstop encoding on the straight-away
02hex	one entrance, two exits, nonstop encoding through the curve

Examples:



Notes!

- Between the two consecutive rail segments (see Track-switch eg. 03hex). The area of Coded Rail 10 **must** have at least 600mm removed with Coded Rail 33 subsequently following. This code rail value under no account can be used in the DKZ area tables.

- On nonstop route areas, the code rail must ascend completely.
  If a rail segment proceeds over a track-switch or lifter cut, so the rail should be transferred continuously and the necessary cut made later. This cut must be clearly bigger than a synchronization bit. We recommend a width of approximately 25-35mm. An interruption of the rail is sometimes necessary at the track switch in order to allow for mechanical clearance. These can be as long as 200mm. The action is performed the same as with the lifter cuts (i.e. first the rail is transferred and then cut out the necessary segment).

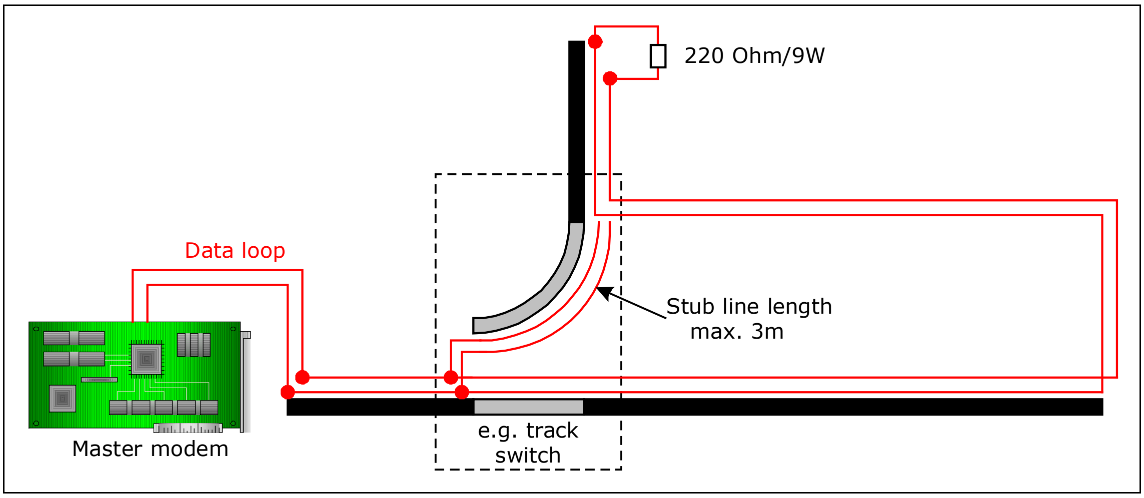
4.4 Laying of the data loop

4.4.1 Laying in the rail bus system (SB)

The data loop is laid in the rail bus system in a **linear structure**.

It consists of a closed conductor loop that is terminated by connecting a resistance of 220Ω/ 9W serially to the loop.

Any possibly required stubs cannot exceed a length of 3 meters, and are to be laid parallel to the main loop and not terminated.



4.4.2 Laying in the inductive EMS (iDB)

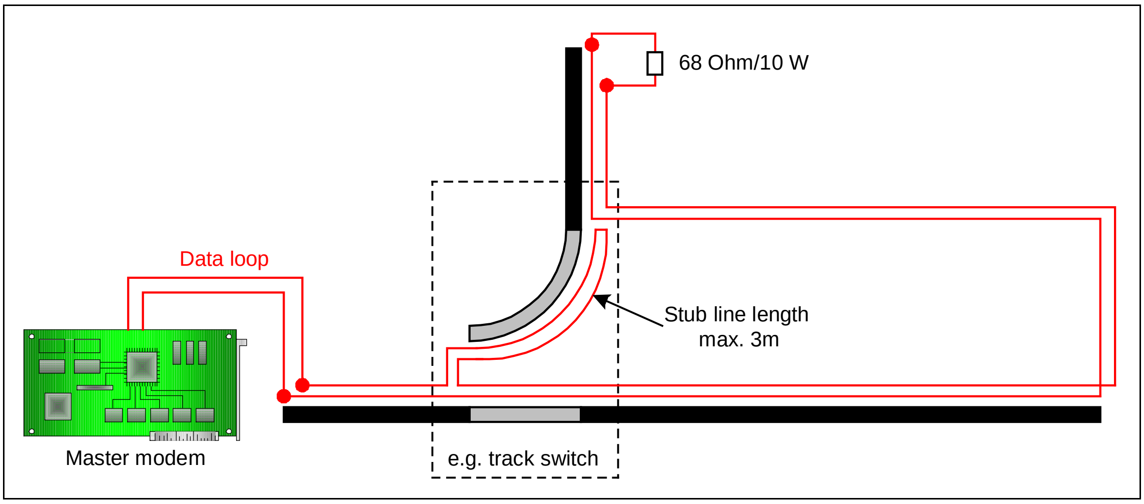
Even here, the data loop should be laid in a linear structure. However, for complex and intensive installation areas, the data loop can be bifurcated into sub-areas through a Y structure or by using another master modem.

All sub-areas are to be terminated with a resistance of 68Ω/ 10W.

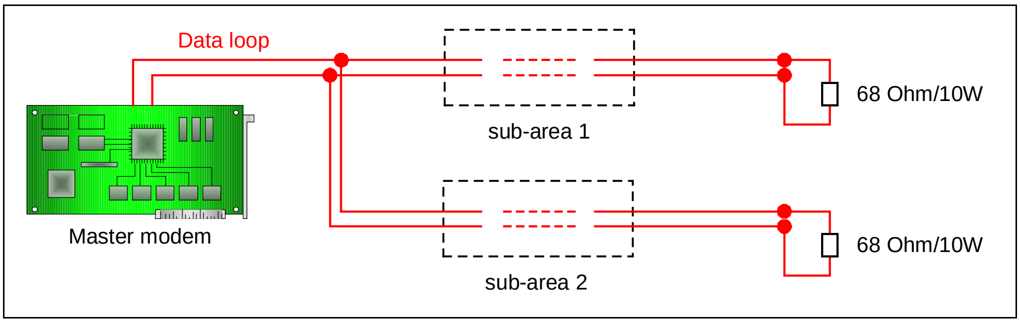
Necessary stub lines within a sub-area cannot exceed a length of 3 meters even here and the stub lines are to be connected in series in the main loop.

System setup

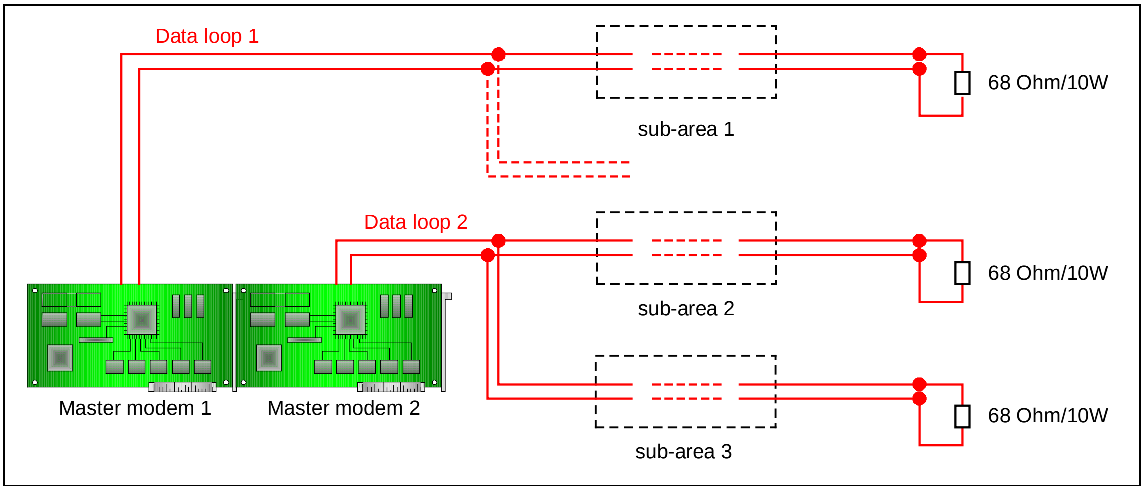
linear structure:



Y structure:



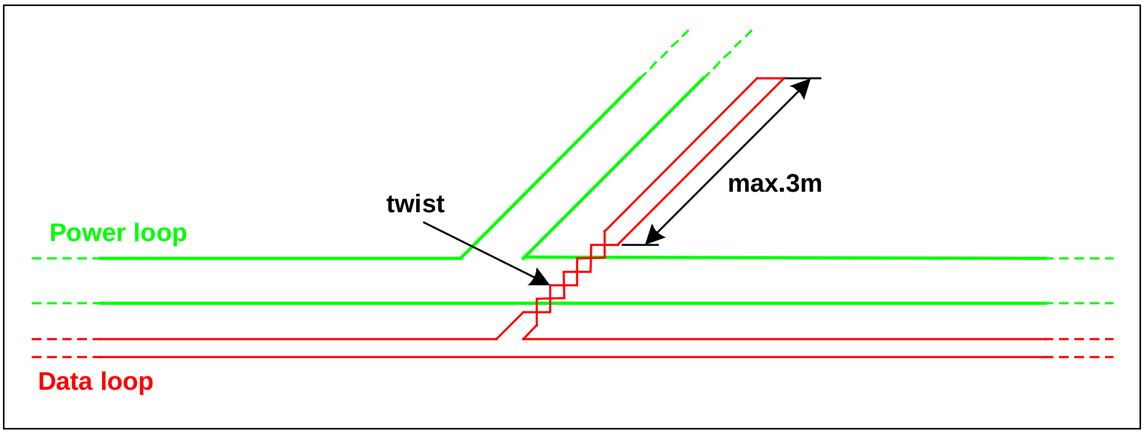
Structure with two master modems:



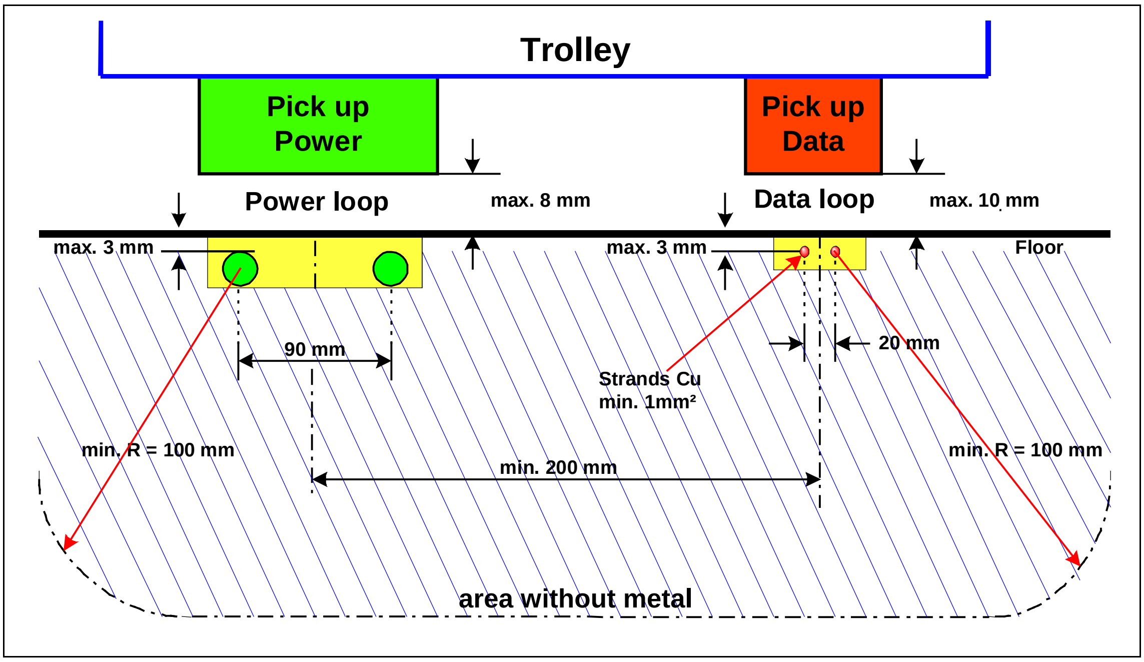
4.4.3 Laying in the inductive FTS (iDB)

In general, the data loop can be laid in the inductive floor transportation systems just like in an inductive EMS (electrified monorail system) (point 4.4.2).
There are special points to be noted while laying the data loop, for instance in the power modules in combination with the laying of the power loop. Certain dimensions have to be maintained during the installation, which are illustrated in the following figures.

Intersections of data and power loops:



Installation specifications for inductive floor transportation systems:



4.5 Commissioning of the data loop

In the EMS, the data loop runs symmetric to the power loop and lies parallel (0°) to the magnetic field plane. Theoretically, there is no coupling. However, the distance between the data and power loops is only a few millimeters (high field strengths) and the least asymmetries in the installation will lead to great interferences. The location of the launching, value and phase position of interference voltages cannot therefore be predicted.

In floor transportation systems on the other hand, the interference effect is high depending on the system. The data loop runs asymmetrically next to the power loop and lies at 90° to the magnetic field plane (maximum coupling). Phase position and value of the interference voltage can in principle be predicted.

Therefore, it is necessary in both cases to survey the data loop and if necessary, match them, to achieve an error-free data transmission via the data bus. The following points illustrate the most important settings and testing methods, which ensure a safe operation of the data bus.

4.5.1 Control of the loop resistance

The loop resistance is determined by measuring the loop resistance of the data loop.

The resistance at the master modem plug is measured for this purpose.
It should correspond approximately to the magnitude of the terminating resistance when the plug is pulled out and the power loop is switched off, i.e.

SB	R = 220 Ω + line resistance
iDB (linear structure)	R = 68 Ω + line resistance
iDB (Y structure)	R = 34 Ω + line resistance

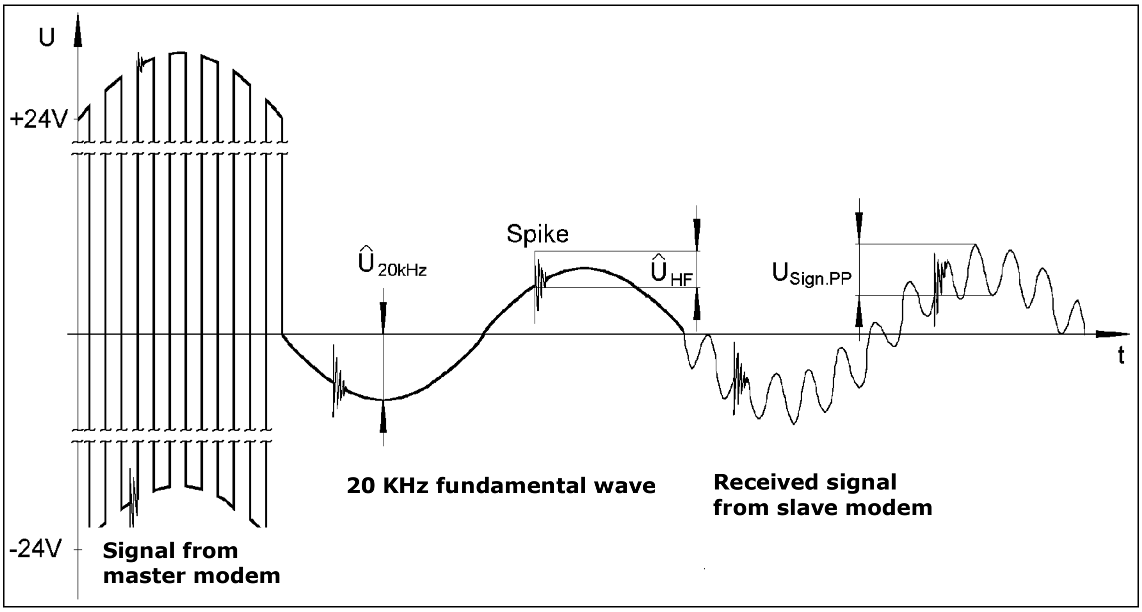
4.5.2 Communication test

The following test is a simple option for checking the communication between the trolley and the data concentrator module via the DKZ.

A trolley is registered in the DKZ area and the communication is checked in the DKZ in the individual trolley menu.
The communication should take place cyclically and without interruption. The letter "c" (communication error) should not appear behind the trolley number. A "c" in the display indicates poor communication between trolley and DKZ. This test is to be performed at all concise points in the loop area. This includes among others, feeders, stub lines, separating areas and power modules.

4.5.3 Oscillographic control at the modem (iDB)

Display of the effective and interfering signals at the master modem:



1. Assessment of the interference voltage compensation

The amplitude of the 20 kHz first harmonic has proven to be a practicable indicator for assessment. Theoretically, a complete deletion is possible; in practice, values of $\hat{U}_{20KHz} = 0{,}1...0{,}2V$ can be achieved. Voltages of $\hat{U}_{20KHz} = 1...2V$ are adequate. There are practical examples, in which an error-free communication is possible even with $\hat{U}_{20KHz} = 3V$.
With the reduction of the amplitude of the 20 kHz first harmonic, the interferences that are caused by the spikes are reduced even though their amplitude $\hat{U}_{HF}$ remains unchanged. Reduction of the interferences can thus be achieved by reducing the 20 KHz first harmonic. For this purpose, the minimum can be determined by the specific interconnection of "pole-reversed" loop sections.
In EMS, only the systematic testing with the reverse poling of individual sections will be successful, since the location and polarity of the interference voltage coupling cannot be prognosed. The existing connecting points in the terminal boxes of the data loop can be used for this. If necessary, additional intersection points have to be created in very long loop sections.
In floor transportation systems, on the other hand, generally the anti phase interconnection of equal length sections will be successful. Nevertheless, it is practical to test whether the result can be improved with an "incorrectly" connected section. In the practical application of the system, unforeseeable influences can lead to deviation from the ideal behavior of a data loop.

2. Spikes

The shape of the spikes can help infer the transmission quality of a data loop.
A periodic, rapidly subsiding course indicates relatively few reflections and thus fewer mismatches. If these spikes still cause a communication failure even when there is a strong effective signal, the capacitive power adaption will turn out to be successful.
An extremely super-elevated cut-in spike and/or a severely aperiodic course of the spikes as well as very slowly subsiding HF oscillations (sometimes until the beginning of the next spike) indicate severe reflections in the loop and are a sign of strong mismatches. Possibly the loop is not terminated or

many terminating resistances are connected in series – check the loop resistance. In addition, if there are low effective signal levels, a capacitive power adaption often does not help any longer and the interfering signals have to be suppressed severely by changing the geometry of the data loop. Either the parts of the loop are assigned to adjacent data loops or the structure has to be broken up and shortened by using a second master modem.
Values of the spikes of $\hat{U}_{HF} = 1...3V$ can be encountered frequently, however the spectral combination of the spikes is also of significance. Thus, an oscillographic assessment of this amplitude does not always lead to a reliable statement.

3. Effective signals

Voltage values of $\hat{U}_{Sign.pp} = 1...3V$ are typical. An undisturbed communication can usually be achieved until $\hat{U}_{Sign.pp} = 0{,}5V$, however the adequate ratio of effective and interfering signals is essential.

4.5.4 Capacitive power adaption (iDB)

The parallel connection of a capacitor to the data loop at the terminals of the master modem leads to a severe damping of the spikes. However, even the effective signal is somewhat reduced. Various capacitance values $C = 2{,}2...22nF$ are meaningful, depending on the ratio of effective/ interfering signals.
A capacitor of $C = 10nF$ has proven to be a typical value.
In the master modem of type MM630 and later models, the capacitors are already integrated in the device and can be hooked up in a staggered manner by means of a hook switch. The commissioning of the data loop always has to begin without capacitance, so as to be able to assess the effective and interfering signal levels.

4.6 Segment classifications

Each DKZ area is divided into individual segments, which have different functions. These serve the logical operation for the DKZ and if existing, the layout control for routing specifications, visualizations, etc.
The number of the segments per DKZ area is restricted on 60.

The various segments are as follows

- **routing segments,**
- **coupling segments,**
- **segments of the power modules,**

and are described as follows in more detail.

4.6.1 Routing segments/routing points

Every "normal "segment of a DKZ area (length, layout dependant) has a routing point assigned to it in the installation table for the entire installation. One calls these segments "routing segments". They allow for exact bearings on the trolley travel in the installation as well as serving later for visualization.

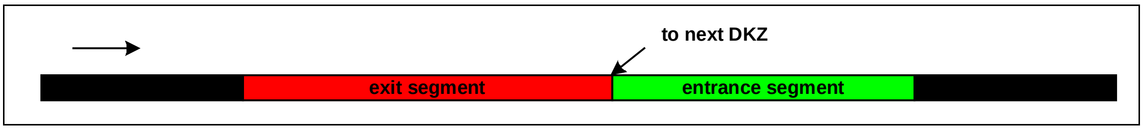
Routing points can be given in any sequence from 1 to 9998.

The points 0 and 9999 are particular points that mark a routing-end (point 0) and endless-route (point 9999). The routing table works from these points as reference.

Also routing points are partially used in power modules. This is explained in more detail in the separate specifications on the configuration of the power modules.

4.6.2 Coupling segments

Coupling segments are at DKZ transitions. They serve to "transfer " the trolleys between one DKZ and its neighboring DKZ over a span in which a communication "handshake" is guaranteed.



Coupling segments are entrance and exit segments. These entrance and exit segments must conform to specific lengths.

Length exit segment	approximately 1000mm, but not bigger than "Trolley length–700mm"
Length entrance segment	min. 300mm

Note!
Lengths are standard values! A decrease of these segments can be realized by reduction of the speeds in these segments. As a counter-move, it may necessary with high speeds to extend these segments.

4.6.3 Segment classifications in power modules

Similar to route segments, the power modules divided into different segments for example collection and feeder segments.

For detailed explanation for the segment division, see specifications of the individual Power module types.

4.7 Configuration/positions/parameterization

The installed DKZ area is configured only after through the production of an installation table and the Power modules are parameterized.

For the preparation of an installation table and for the division of the DKZ area into segments, is it necessary for important positions to be shown as absolute positions in millimeters.

A trolley controller and trolley are used to specify the points in the DKZ area. The trolley is either used in hand mode per remote handling or is pushed through the area.

Important positions:

- Positioning points (e.g. on hoists, lift tables)
- first position in the DKZ area after DKZ transfer at entrance
- last position in the DKZ area at exit
- positions at code rail change (e.g. on track switch routes)
- positions in front of power modules, in which the trolley is not yet in the separation area
- positions behind power modules, in which the trolley is completely free of the separation area.

Example, see chapter 5.4.1

The final parameterization of the individual DKZ areas takes place with help of a PC based parameter tool.

See description Dkz-Para!
The parameterization procedure of the DKZ is extensively detailed in a separate description described.

5 Complete example

In the following, the fore-mentioned components comprise a total example. The DKZ area 56 (equipped with iDB) is from chapter 4.1 and is in more detail described.

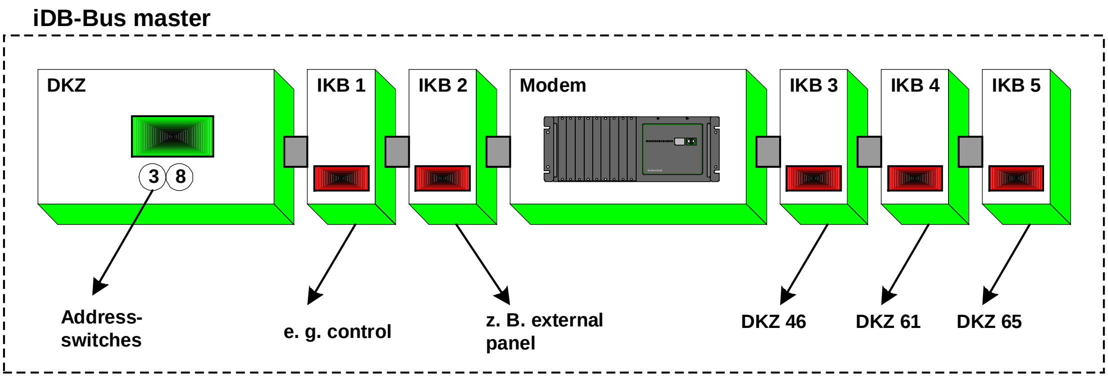
existing from:

- Data concentrator module
- iDB modem module
- five IKB modules
- simple track switch Type 03hex (2 entrances, 1 exit, nonstop code rail on straight-away)
- three neighbors DKZs (2 entrances from DKZ 46 and 61 as well as one exit to the DKZ 65)

5.1 Build-up of the DKZ control unit

The control and administration of the DKZ area is assisted with its additional modules. This is summarized as a control unit, the Data Concentrator.

These are exampled as follows:



The DKZ area is addressed in the installation and gets its DKZ "name" (number), as an address. The address counters of the data concentrator module must be selected as value 38, that corresponds decimal to the 56 (address switches are in hex).

IKB 1 and IKB 2 are used for the connection to external devices (DNC's, HMI's, as well as control canels) and through the data concentrator module get the addresses 2 and 3. The IKB modules 3 to 5 are used for the neighboring DKZs as connection modules. The DKZs get the addresses 4 (IKB 3), 5 (IKB 4) and address 6 (IKB 5).

Note!
Coupled DKZs are given only from address 4+ in principle. All IKB connections are configured over the Parameter PC.

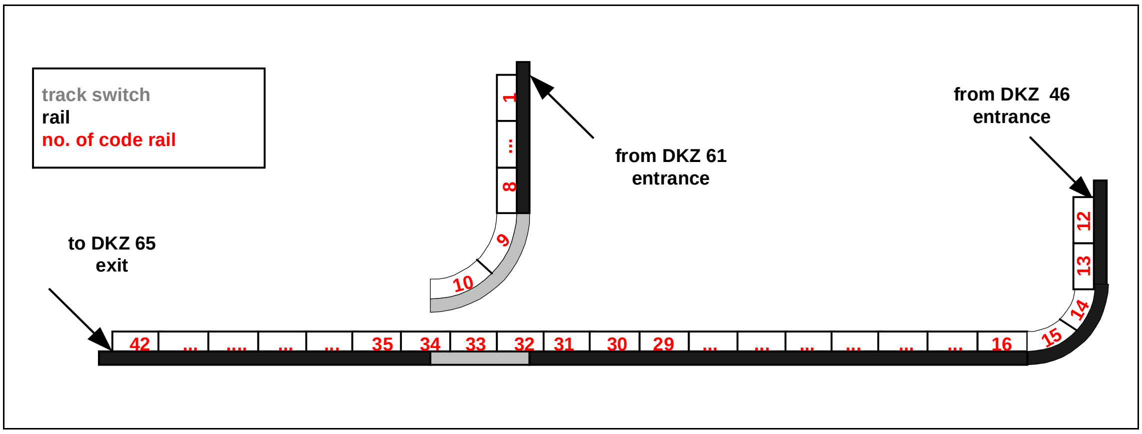
The overview has the IKB modules also in ascending sequence as the neighbor DKZs are wired (i.e. here in our example IKB 3 for the connection to the neighbor DKZ 46 - IKB 4 for the connection to the neighbor DKZ 61 and IKB 5 for the connection to the neighbor DKZ 65.)

The mounting of the modem can take place at any place behind the data concentrator module.

5.2 Code rail installations

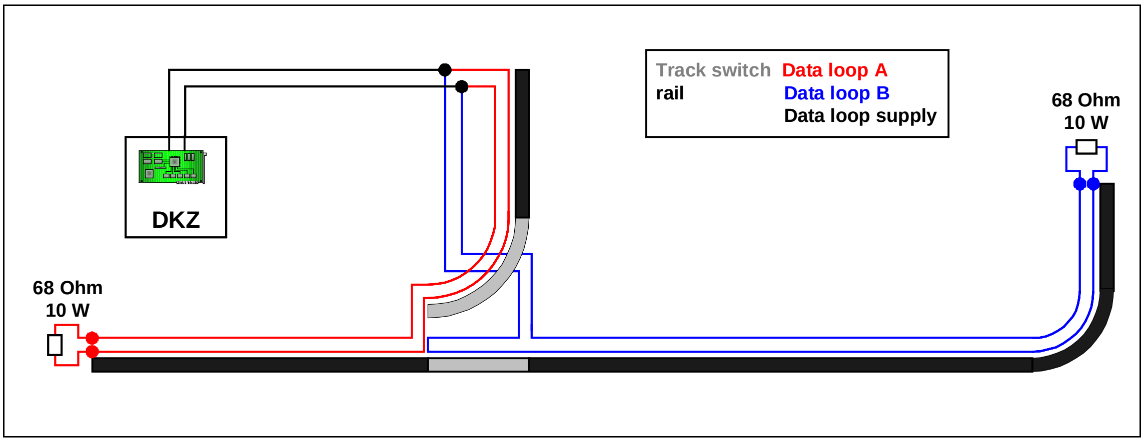
The following representation shows the code rail installation in the DKZ area. The code rails from 1 until 42 are used and are in ascending sequence. Since a track switch (type 03hex) is used, the code of the 2nd entrance takes the place of transferring the nonstop code over the straight-aways and finishes on the Curve of the track switch with the code rail no.10.

As described in the chapter, "Installation in power modules ", the code rail no.11 doesn't get entered in the DKZ area.



5.3 Data bus laying

The Y structure was selected in this example for the data bus laying, i.e. the data bus is bifurcated into two sub-areas, A and B and are connected parallel to each other and each of them is terminated with a terminating resistance of 68 Ω.



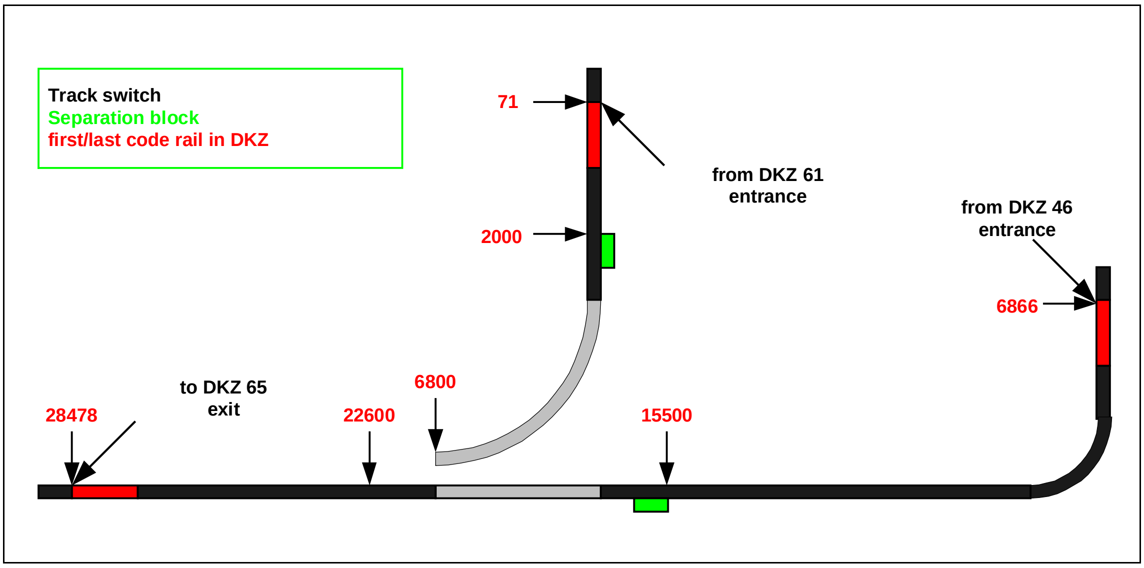
5.4 Segments and routing

The trolleys are routed through the DKZ area with the help of fixed routing points. For this, the area is divided into segments and a routing point is assigned later to the individual segments through the system table with the help of a parameterizing computer.

5.4.1 Position recording

For the preparation of an installation table and for the division of the DKZ area into segments, is it necessary for important positions to be shown.

data reclarafication positions (red digits)**:**



Position 71	first code for entrance from DKZ 61
Position 2000	position of entrance in the track switch separation area (curve)
Position 6800	end code for not continuously transferred code rail area
Position 6866	first code for entrance from DKZ 46
Position 15500	position of entrance in the track switch separation area (straight)
Position 22600	position, with which the driving trolley left the track switch completely
Position 28478	last code for exit to the DKZ 65

5.4.2 Segment division and routing point assignment

After picking up of the positions in segments, the area is divided.

This example DKZ area is divided into the following 10 segments:

Coupling segments	
Segment 1	entrance from DKZ 61 (position 71 to 500)
Segment 4	entrance from DKZ 46 (position 6866 to 8000)
Segment 10	exit to DKZ 65 (position 27301 to 28478)

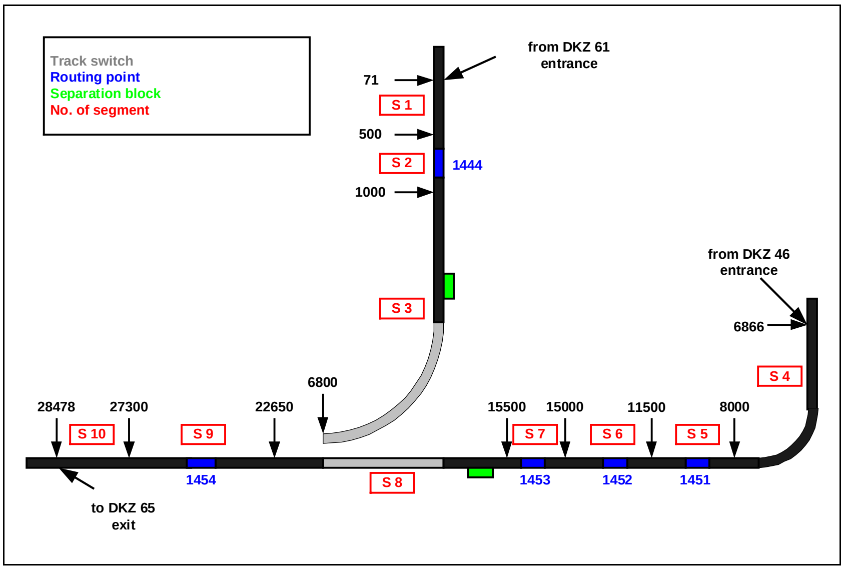
Track segments	
Segment 5	1st segment (position 8001 to 11500)
Segment 6	2nd segment (position 11500 to 15000)

Track switch segments	
Segment 2	1st allocation segment (in front of the separation area)(position 501 to 1000)
Segment 3	inner segment curve (position 1001 to 6800)
Segment 7	2nd allocation segment (behind of the separation area)(position 15001 to 15500)
Segment 8	inner segment straight (position 15501 to 22650)
Segment 9	release segment (Weiche frei) (position 22651 to 27300)

Straight segments are connected to create decisive segments so that the Parameter Calculator (see specific documentation) can assign routing points. In this way, every segment in the layout table is known, which serves to navigate the trolley through the area.

Segment division and routing points are illustrated in the following figure.

> **Note!**
> No routing points are given to coupling segments or inside power module segments! However, positioning points are the exception in power modules, and are inferred from the specific power module description.



5.4.3 Routing

Trolleys can have (with the help of the PLC, or MU devices) a routing table sent. It is on this occasion that the table must be completely written. There can be no omitted routing points on the route Way. The trolley must receive the complete table at the first, or before the last routing point of the written table before it can decide its route way.

Examples:	
Routing table: 1451;1452;1453;1454;**0**	trolley drives from point 1451 to 1454 and waits for a new table there
Routing table: 1454;1453;1454;**9999**	trolley drives indefinitely between the points 1454 and 1453 back and forth
Routing table: **0**	current Routing table is deleted