

ZUB® 200 Automatic Train Control System



ZUB[®] 200 Automatic Train Control System Area of Application

Aims

- Bidirectional exchange of information between track and vehicles
- Transmission of data relevant to
 - safety
 - operation

Application

- Light rail transit systems
- Regional and mass transit systems
- Main-line rail traffic
(depending on the transmission channel used, for speeds up to 500 km/h)



ZUB[®] 200 Automatic Train Control System Signalling and Safety Functions

- Transmission of signal and line information to the vehicle
- Continuous monitoring of the permissible speed and braking
- Initiation of braking when the speed limit is exceeded
- Train stop at stop signals
- Monitoring of temporary speed restriction sections
- Information and warning of the driver
(display of target and actual speed, acoustic alarm)

ZUB[®] 200 Automatic Train Control System

Data Transmission Functions: Data Transmission to Vehicle

Data transmission from track to vehicle

- Door release side
- Step board height
- Balises for detecting the location and resetting the measured distance, forwarding the data to the operations control centre via train radio
- Traction voltage change

- Further customer-specific data
 - Light switching
 - Fare zone switchover
 - Radio channel switchover



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Data Transmission Functions: Data Transmission to Track

Data transmission from vehicle to track

- Point control commands
 - Manually via pushbuttons
 - Automatically via the IBIS interface
(integrated on-board information system)

- Vehicle number message

- Road-traffic signal request



ZUB® 200 Automatic Train Control System Customer Benefits

- High level of automation
- High level of safety and availability
- Tailor-made solutions



ZUB[®] 200 Automatic Train Control System High Level of Automation

- Increased transport capacity
 - Short headways (90 s and less, depending on the signalling system)
 - Optimum train speed
- Automatic monitoring
 - Continuous and reliable monitoring of speed and braking
 - Display of target and actual speed in the driver's cab
 - Acoustic alarm if the target speed is exceeded and automatic triggering of the brakes
 - Train stop at stop signals
 - Support of the train crew (e.g. door release side, speed profile monitoring)



ZUB[®] 200 Automatic Train Control System High Level of Safety and Availability

- High operating safety
 - Requirement category 6
in accordance with DIN V 19 250
 - Safety Integrity Level 2 or 3
in accordance with CENELEC standard EN 50 128
(depending on system size and transmission channel)
- Use of the SIMIS[®] fail-safe microcomputer system from Siemens
 - Safety using a 2-out-of-2-configuration
- High operating reliability due to tried-and-tested components and transmission channels
- High availability and minimum downtimes due to simple, comfortable and improved diagnostics equipment
- Many years of operating experience under all climatic and operating conditions, more than 5,000 ZUB on-board units in service



ZUB® 200 Automatic Train Control System Tailor-made Solutions

- Incorporation into existing operating rules
 - Integration in existing signalling systems
 - Compatibility with existing ZUB-equipped lines
- Capacity for expansion and extension with modules and additional interfaces
- Combination of up to two specific transmission channels possible
- Long life and low maintenance outlay because there are no wearing parts
- Modern diagnostics system for rapid fault location



ZUB[®] 200 Automatic Train Control System

Comparison Continuous Versus ZUB Automatic Train Control

	Continuous	ZUB
Emergency braking	yes	yes
Automatic train protection (ATP)	yes	yes
Automatic train operation (ATO)	yes	planned

System selection

- does not depend on **headway**,
- but on **operating mode** and **line layout**.

Siemens has successfully implemented mass transit systems with headways of 90 s and shorter using automatic train control systems.

ZUB[®] 200 Automatic Train Control System System Features (1)

- Easy, non-reactive extraction of the information at the signal
- No additional power supply for the track coupling coil/loop
- Transmission of telegrams via an air gab
- No cross talk to the data source in the adjacent track
- Suitable for a train speed of
 - maximum 500 km/h when using balises
 - maximum 220 km/h when using coupling coils

ZUB® 200 Automatic Train Control System System Features (2)

- Insensitive to electrical and magnetical interference
(extensive experience in mass transit and main-line traffic
with more than 5,000 on-board units)
- Used in all climates by different customers under the
regional weather conditions (heat, rain, hoar-frost, snow)
- Robust design to cope with the high level of mechanical shock
and vibration loading
- Low space requirements
(single-level 19" rack for the compact version)
- Software changes via download interface

ZUB® 200 Automatic Train Control System Options

- Manual point control by means of pushbuttons
- Automatic point control by means of the IBIS interface based on continuous transmission of a route identifier
- Location detection at fixed points (balises) for onward transmission of the data to the operation control centre via train radio
- Reliable processing of distance and speed information from other systems via the MV bus (multifunction vehicle bus) – ZUB odometer pulse generator/radar is not needed in this case
- Supply of train dynamics data to the vehicle control computer from ZUB 200 via MV bus
- Connection to a multifunctional man-machine interface instead of the ZUB control unit

ZUB[®] 200 Automatic Train Control System System Design: Components and Structure

Components

- SIMIS[®] family computers
- 2-out-of-2 system with hardware comparison
- Tried-and-tested peripheral equipment
- Tried-and-tested inductive transmission method with 850 kHz

Structure

- Division into basic functional blocks (computer, distance measurement, transmission, input/output, power supply)
- Additional transmission channels available as an option (among others Eurobalise has been implemented)
- Connectable to vehicle data buses as an option (multifunction vehicle bus or DIN bus)

ZUB[®] 200 Automatic Train Control System System Family



ZUB 200-Family

Transmission medium

1 (ZUB 212) = audio frequency

2 (ZUB 222) = 850 kHz channel

3 (ZUB 232) = audio frequency and
850 kHz channel

4 (ZUB 242) = Eurobalise

6 (ZUB 262) = 850 kHz channel and
Eurobalise

Dual-channel computer

Compact version

System family ZUB 2X2c

ZUB[®] 200 Automatic Train Control System References

- ZUB 212**
 - Egyptian National Railways (ENR/Bahariya Line), Cairo, Egypt
 - üstra Hannoversche Verkehrsbetriebe AG, Hanover, Germany
- ZUB 222**
 - Stadtbahn Saar GmbH, Saarbrücken, Germany
 - Stuttgarter Straßenbahnen AG (SSB), Stuttgart, Germany
- ZUB 222c**
 - Dortmunder Stadtwerke AG, Dortmund, Germany
 - Shanghai Metro Construction Corporation, Ltd. (SMCC), Shanghai, China
- ZUB 232**
 - Rotterdamse Elektrische Tram (RET), Rotterdam, Netherlands
- ZUB 242**
 - S-Bahn Berlin GmbH, Berlin, Germany
- ZUB 262**
 - German Railways (DB AG), Berlin, Germany
- ZUB 262c**
 - SBB Cargo (Swiss Federal Railways), Basel, Switzerland
 - DB Cargo AG (German Railways), Mainz, Germany



ZUB® 200 Automatic Train Control System References of the Predecessor System ZUB 100

- ZUB 110** ■ Athens Piraeus Electric Railways S.A., Athens, Greece
- ZUB 111** ■ Egyptian National Railways (ENR/Bahariya Line), Cairo, Egypt
 - Central Railway (CRly), Mumbai (Bombay), India
 - Western Railway (WRly), Mumbai (Bombay), India
- ZUB 121** ■ Swiss Federal Railways (SBB), Bern, Switzerland
- ZUB 122** ■ Azienda Transporti Milanesi (ATM), Milan, Italy
 - Dortmunder Stadtwerke AG, Dortmund, Germany
 - Gemeentevervoerbedrijf Amsterdam (GVB), Amsterdam, Netherlands
 - Stadtwerke Bielefeld GmbH, Bielefeld, Germany
 - Storstockholms Lokaltrafik (SL), Stockholm, Sweden
 - Stuttgarter Straßenbahnen AG (SSB), Stuttgart, Germany
- ZUB 123** ■ Danish Railways (DSB), Kopenhagen, Denmark



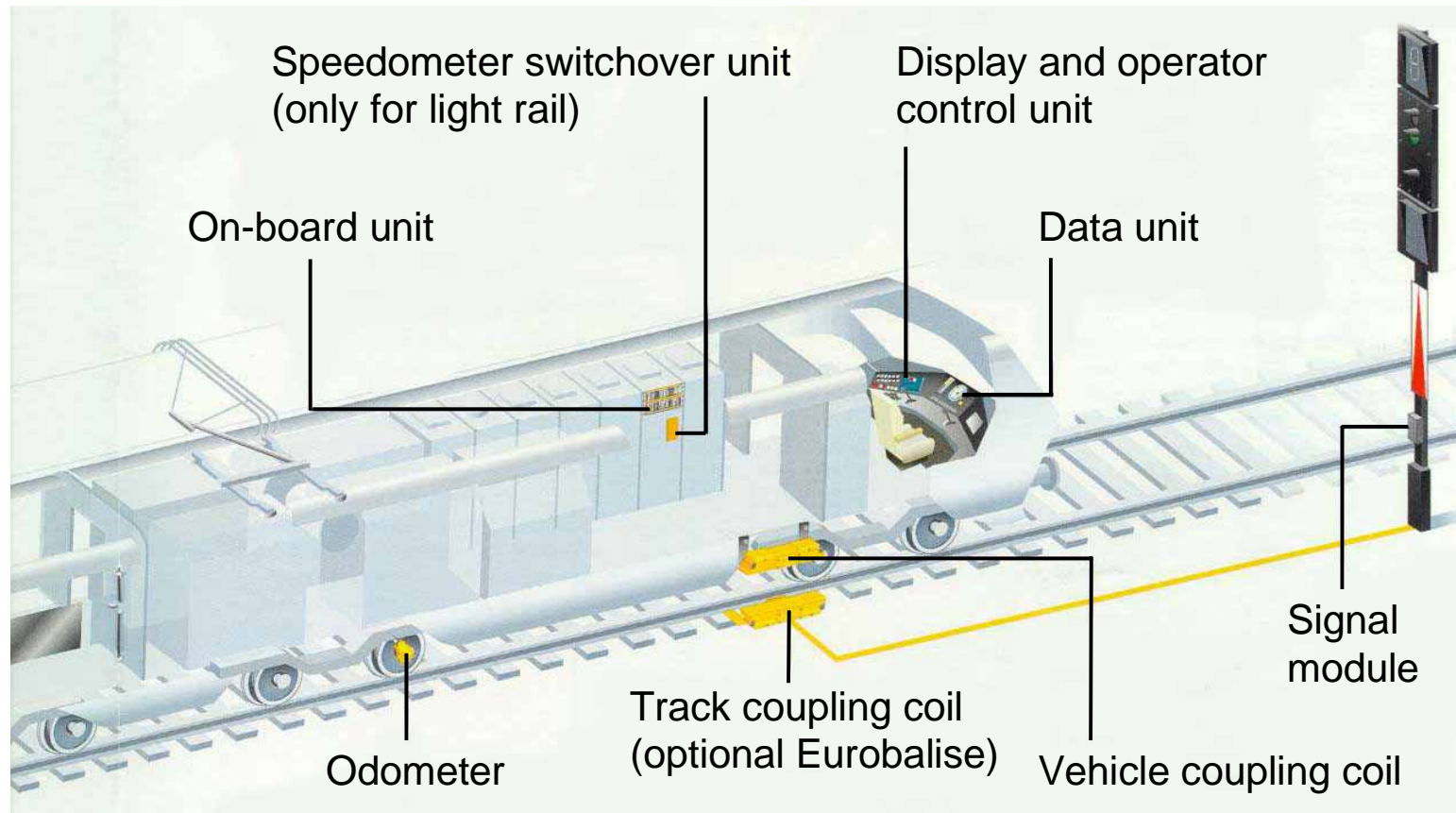
ZUB[®] 200 Automatic Train Control System Main-line Applications

ZUB 200 for all **safety-related** and **functional** requirements

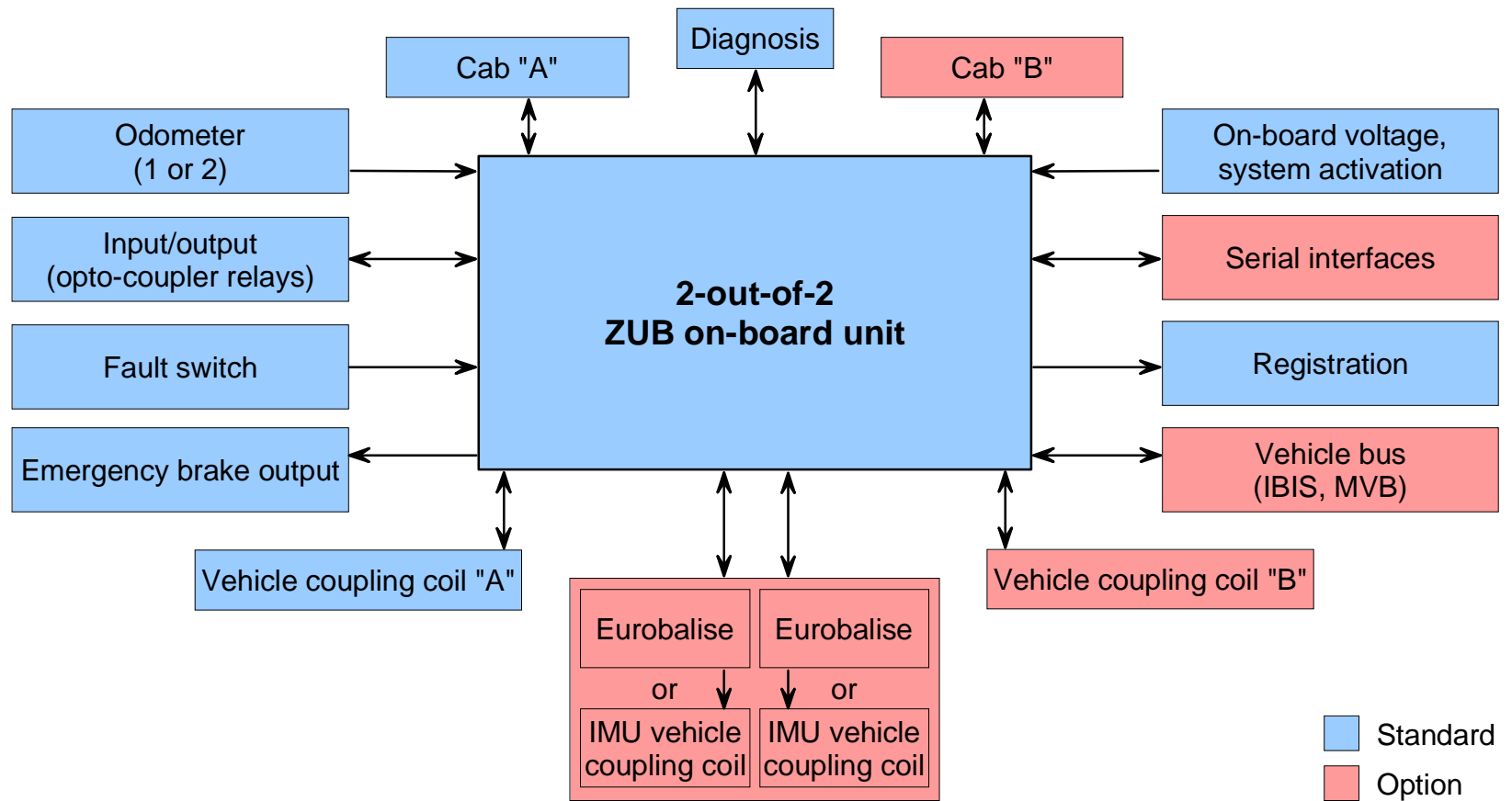
- Example: Eurobalise
 - With transmitter/receiver unit similar to the ZUB coupling coils as European standardised interface between vehicle and track
 - Used in European cross-border traffic
- Example: with the Pendolino (VT 612 series of the German Railways)
 - Trains with a special tilting technology
 - Monitoring of the speed in curves depending on the tilting angle



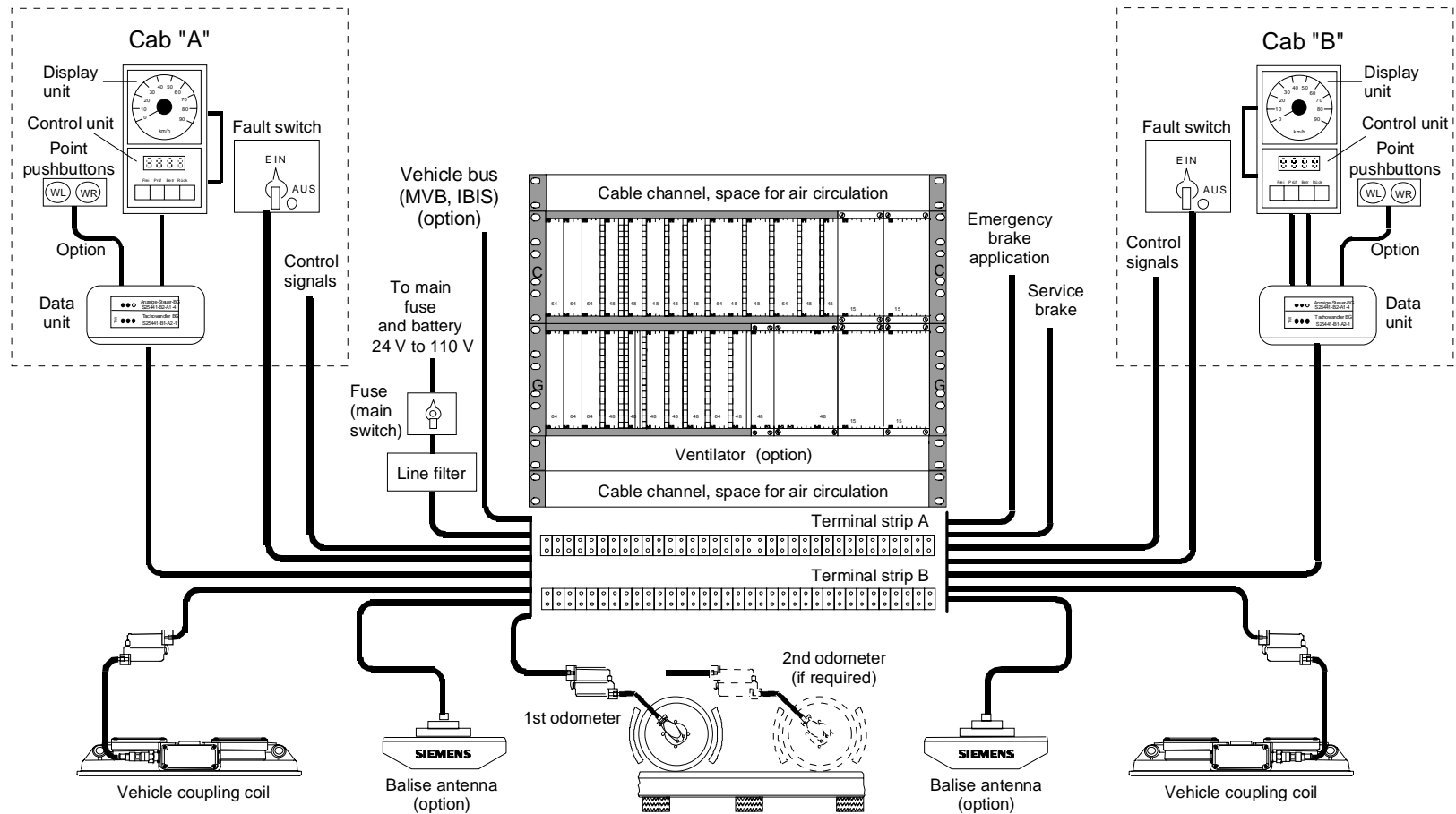
ZUB[®] 200 Automatic Train Control System Automatic Train Protection Components



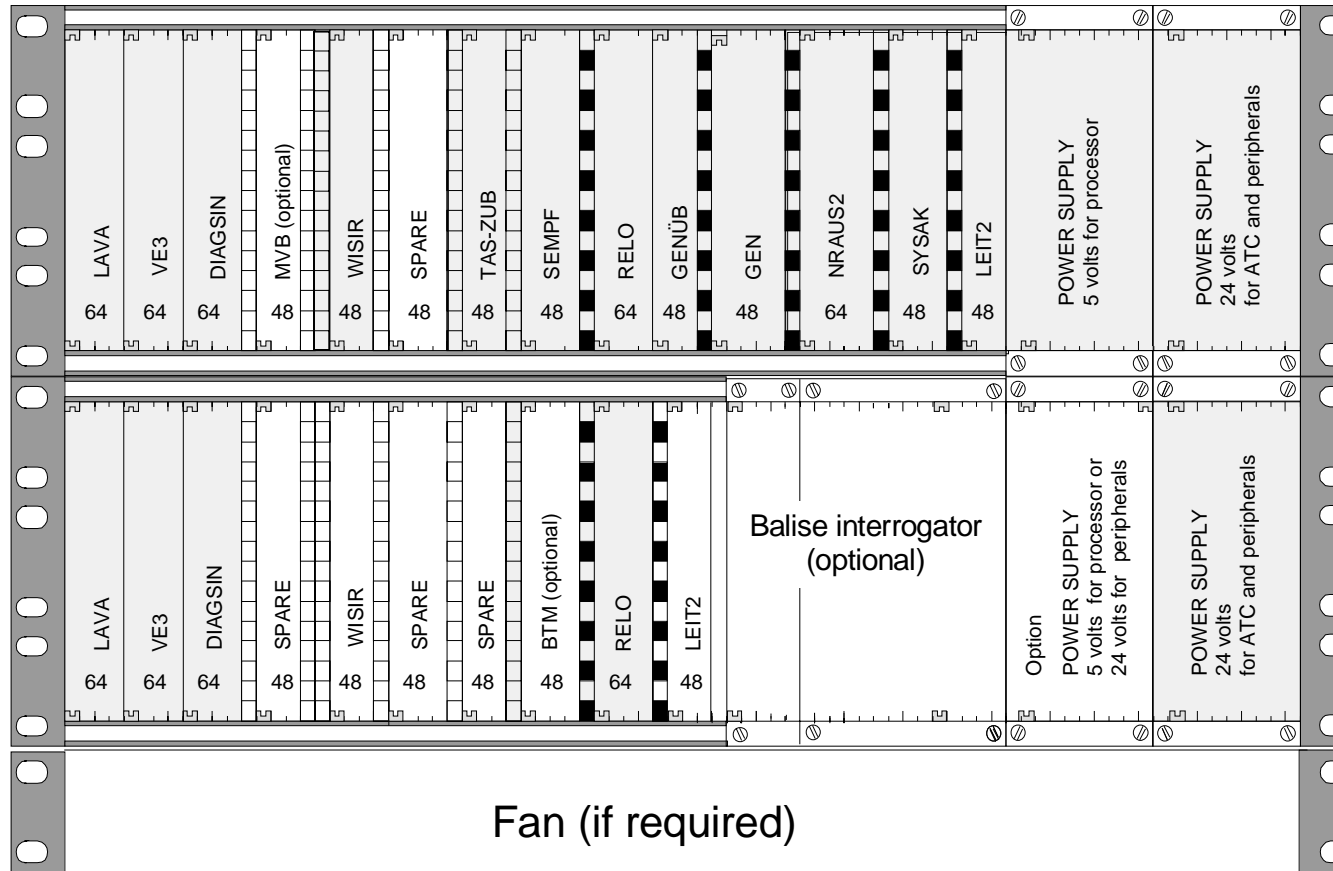
ZUB[®] 200 Automatic Train Control System System Interfaces



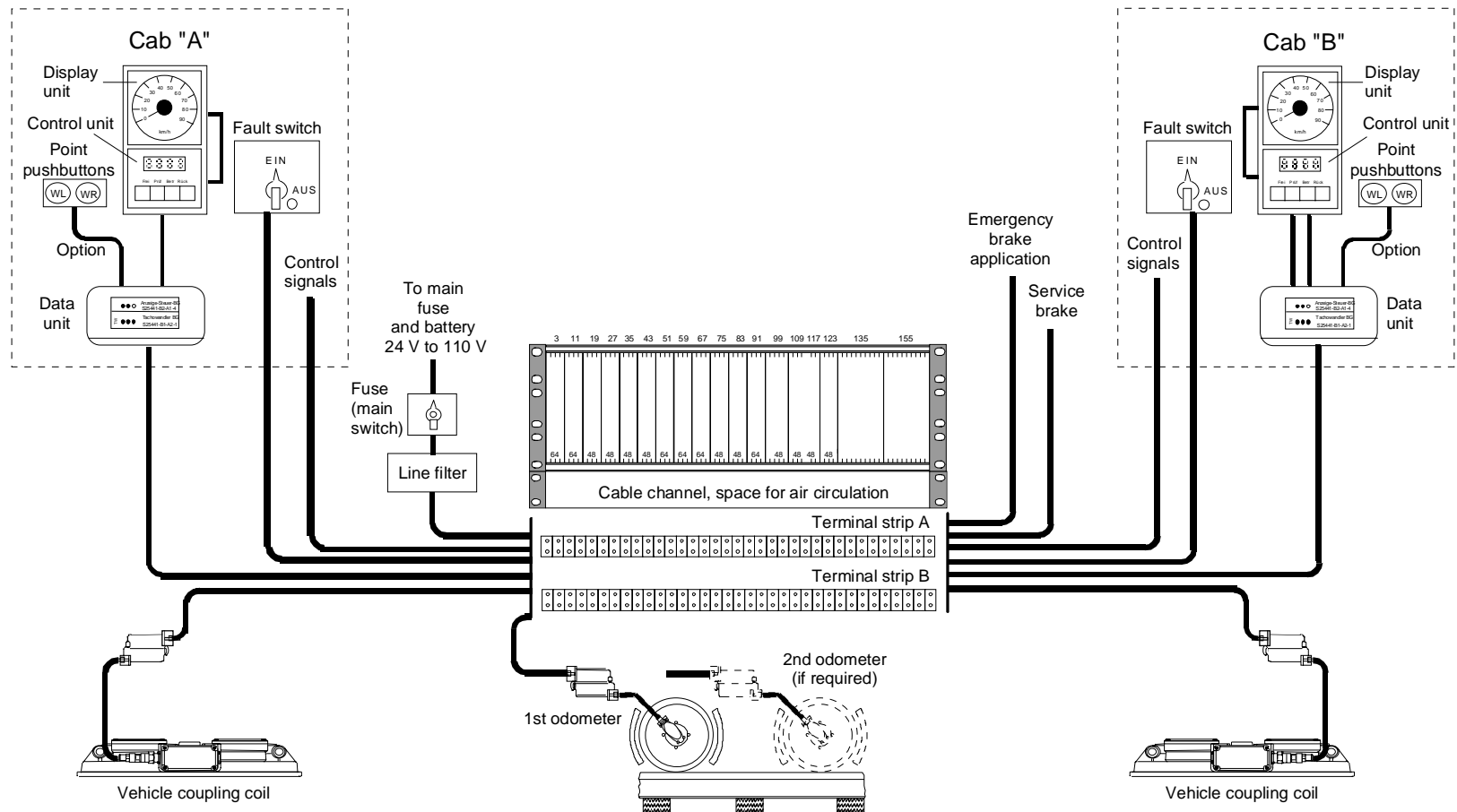
ZUB[®] 200 Automatic Train Control System Configuration of the On-board Equipment



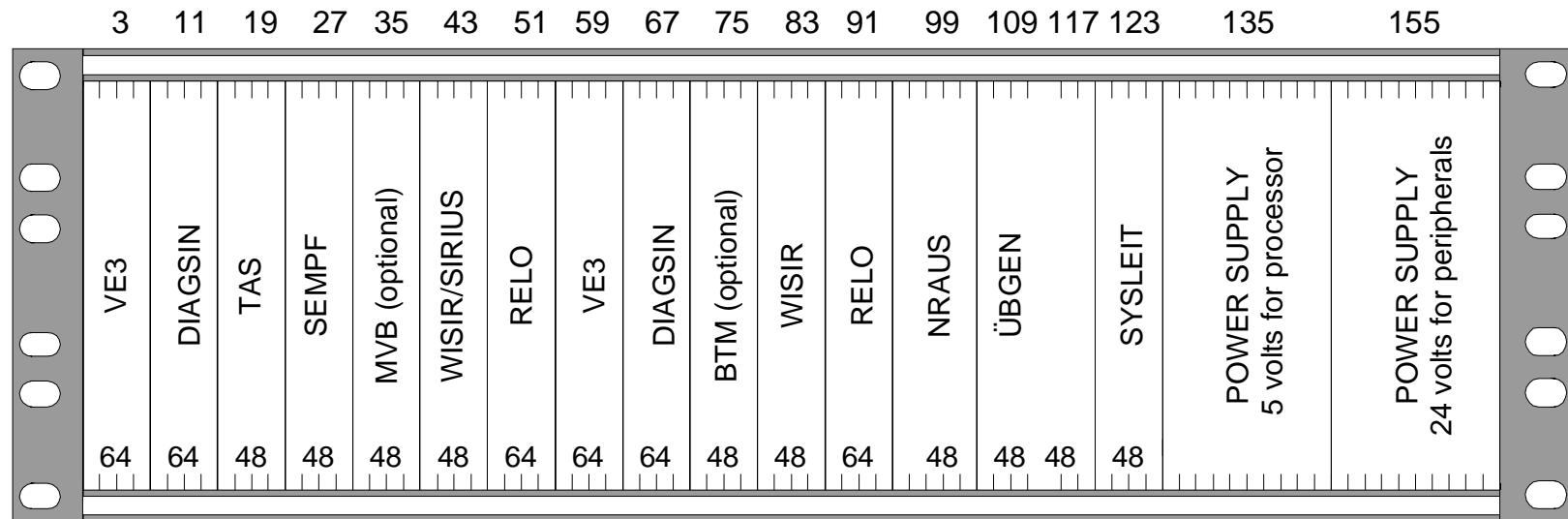
ZUB® 200 Automatic Train Control System Mounting Frame of On-board Unit



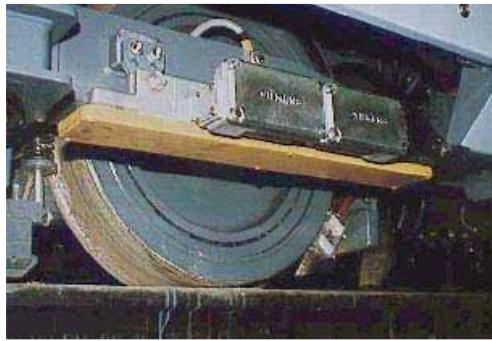
ZUB[®] 200 Automatic Train Control System Configuration of the On-board Equipment (Compact Version)



ZUB[®] 200 Automatic Train Control System Mounting Frame of On-board Unit (Compact Version)

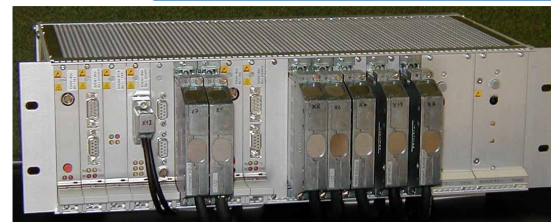
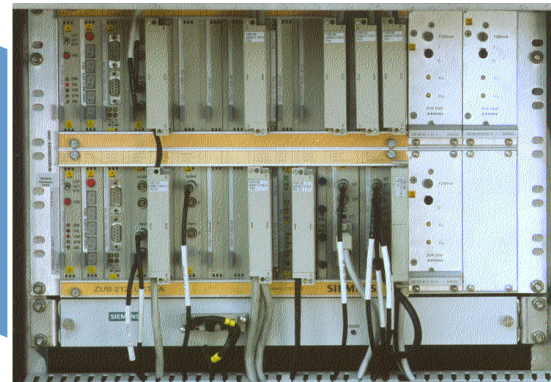


ZUB[®] 200 Automatic Train Control System Vehicle Equipment



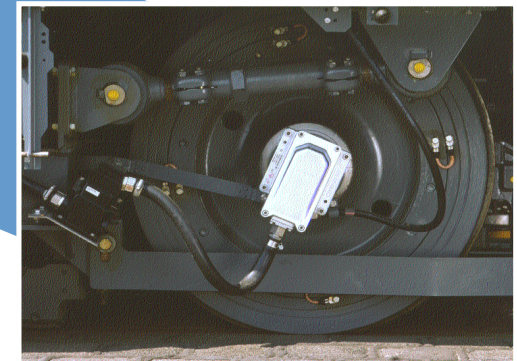
Vehicle coupling coil

On-board unit (ZUB 212)



On-board unit (ZUB 222c)

Odometer

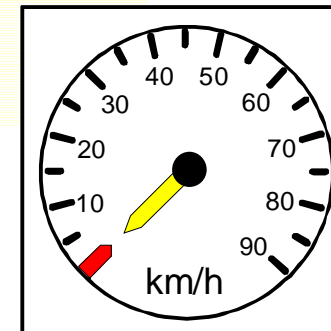


ZUB[®] 200 Automatic Train Control System Cab Displays

Speedometer:

Red pointer: Maximum permissible speed

Yellow pointer: Current train speed



Digital display:

Four-digit seven-segment display for target speeds and messages

Lamp:

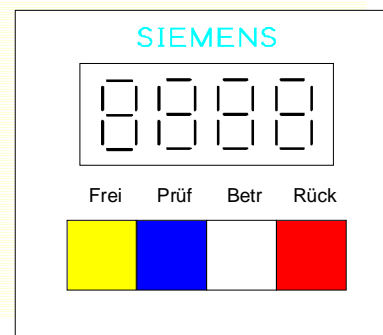
White: System active

Lighted pushbuttons:

Yellow: Authorised move

Blue: System test

Red: Emergency brake

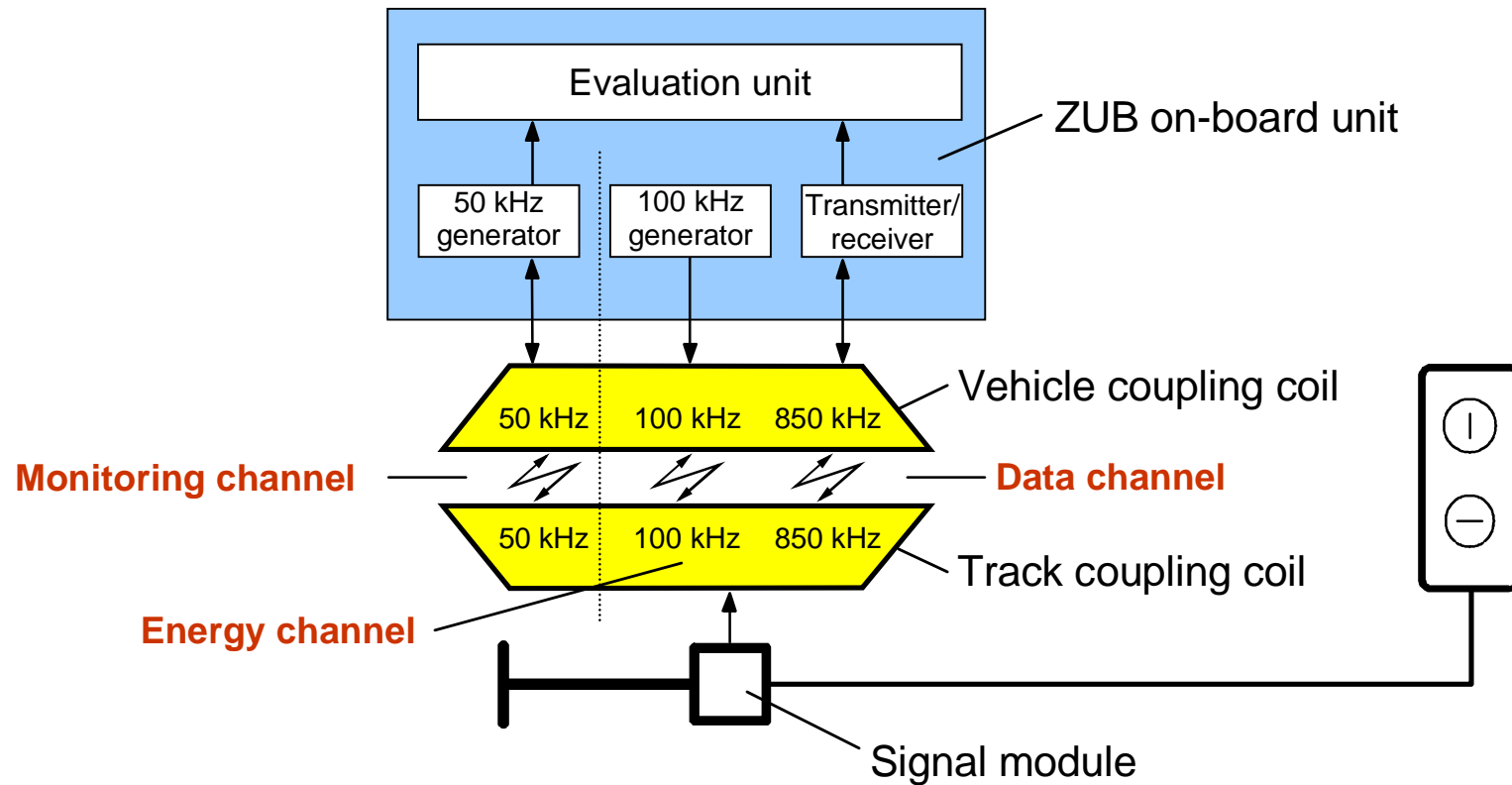


Audible signal generator:

Warning in case of exceeding the speed

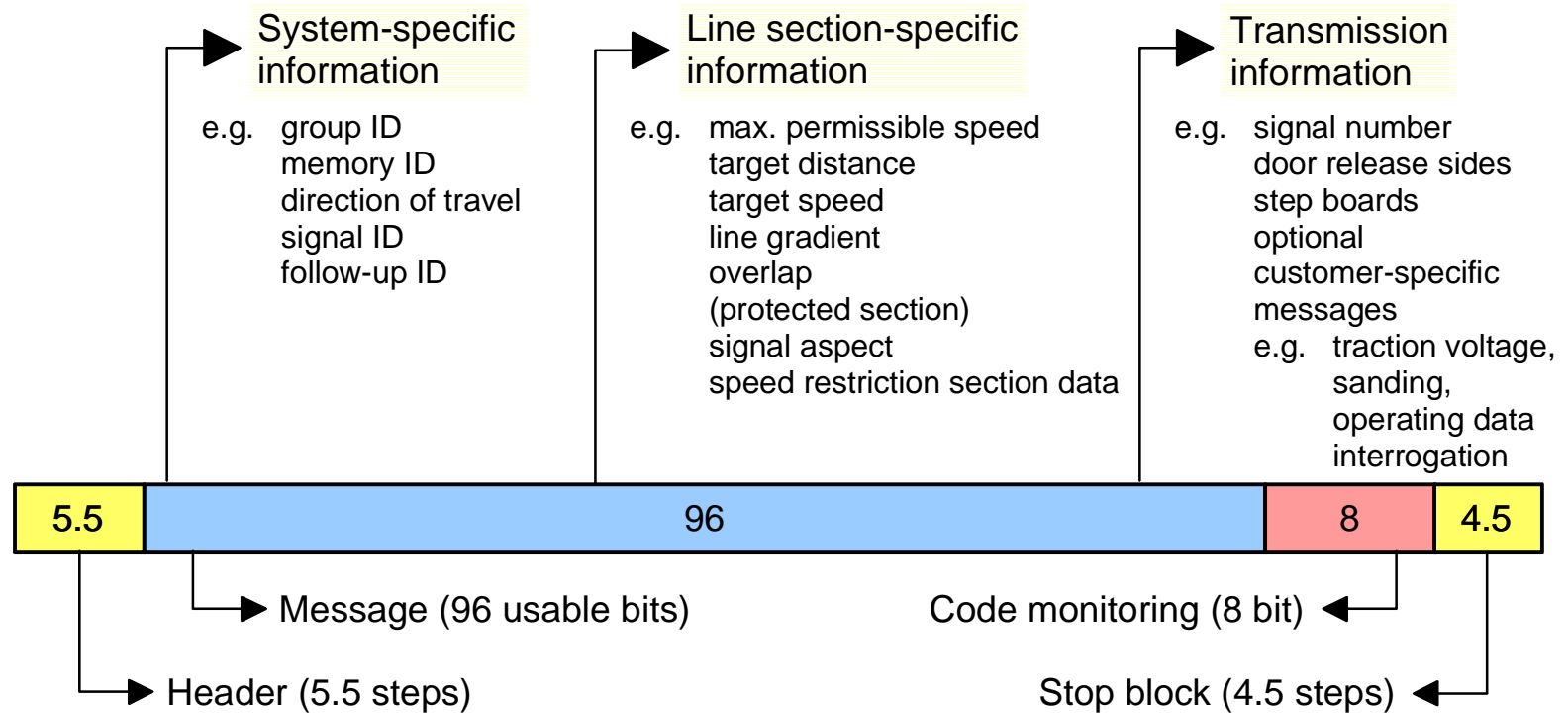


ZUB[®] 200 Automatic Train Control System Transmission Principle for Coupling Coils

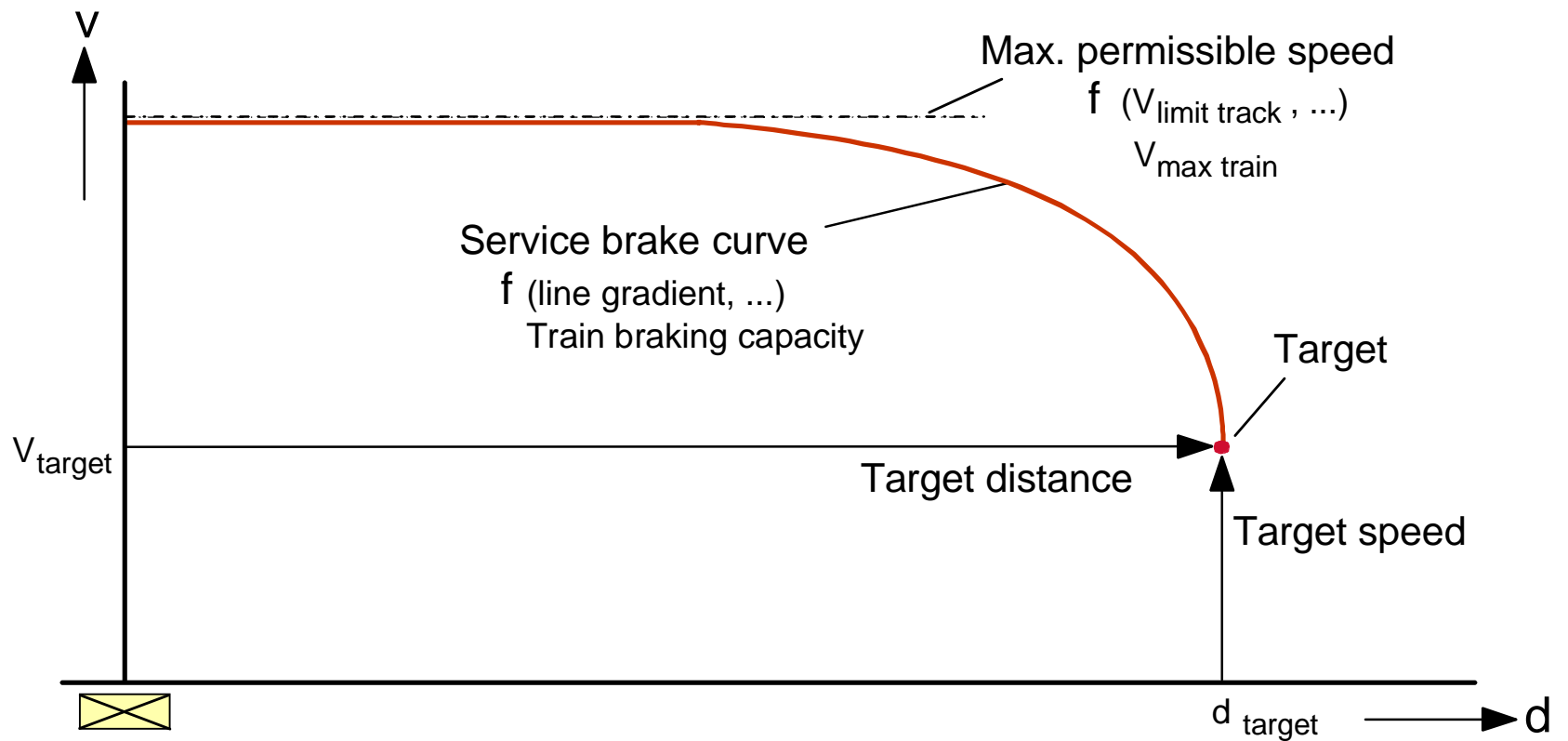


ZUB[®] 200 Automatic Train Control System

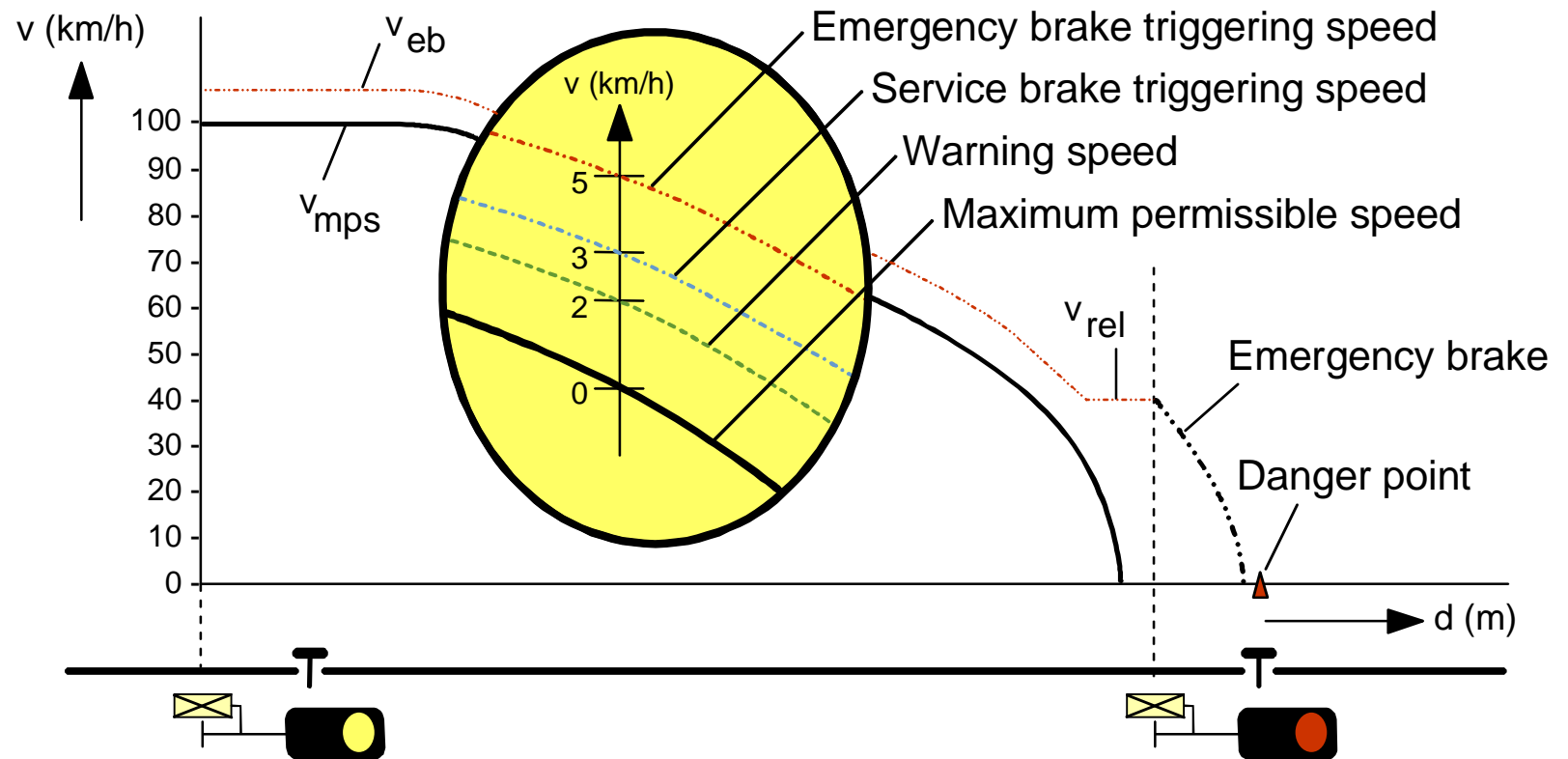
Example of Telegram Structure (Line ⇌ Vehicle)



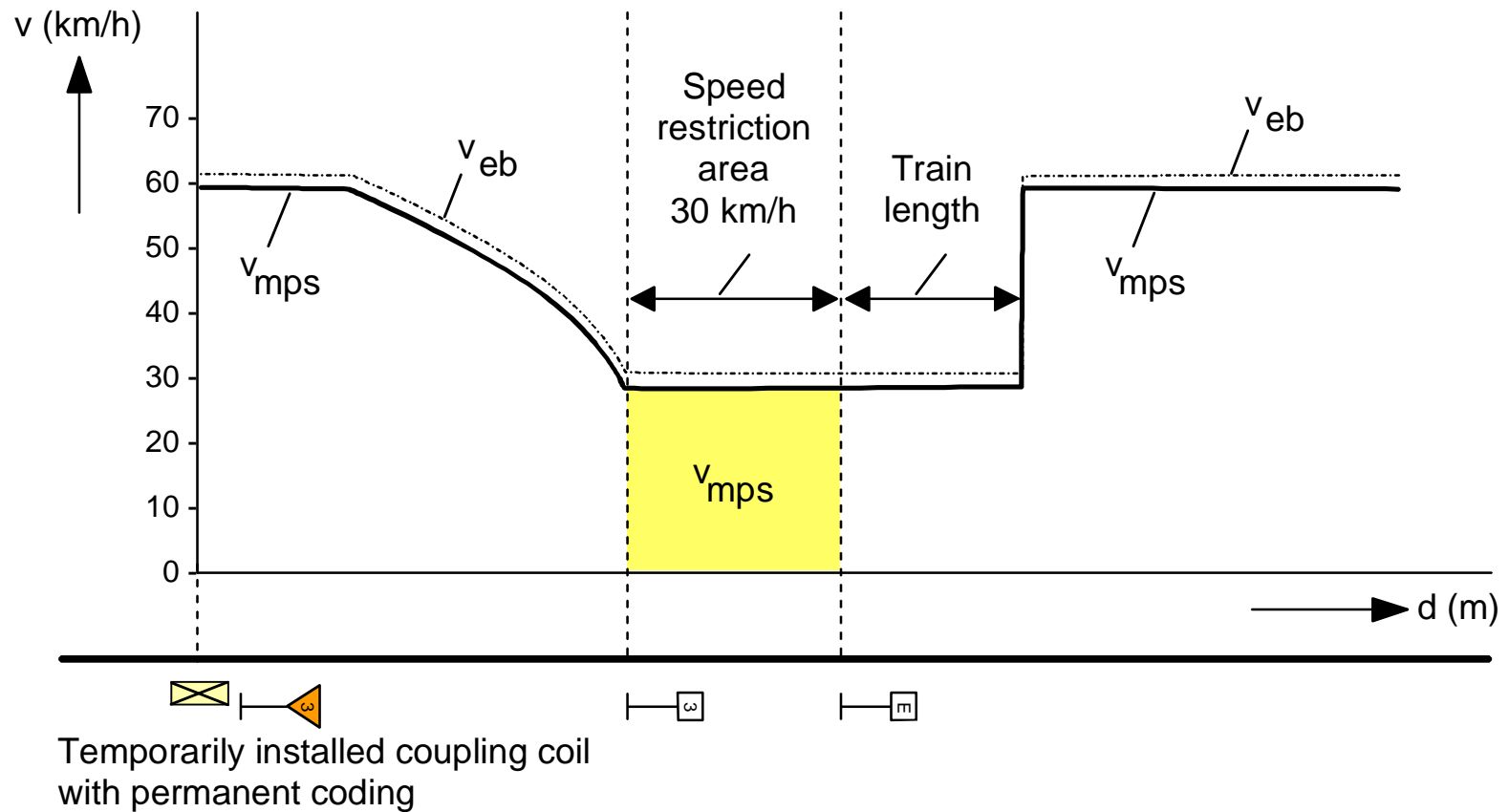
ZUB[®] 200 Automatic Train Control System Monitoring Profile



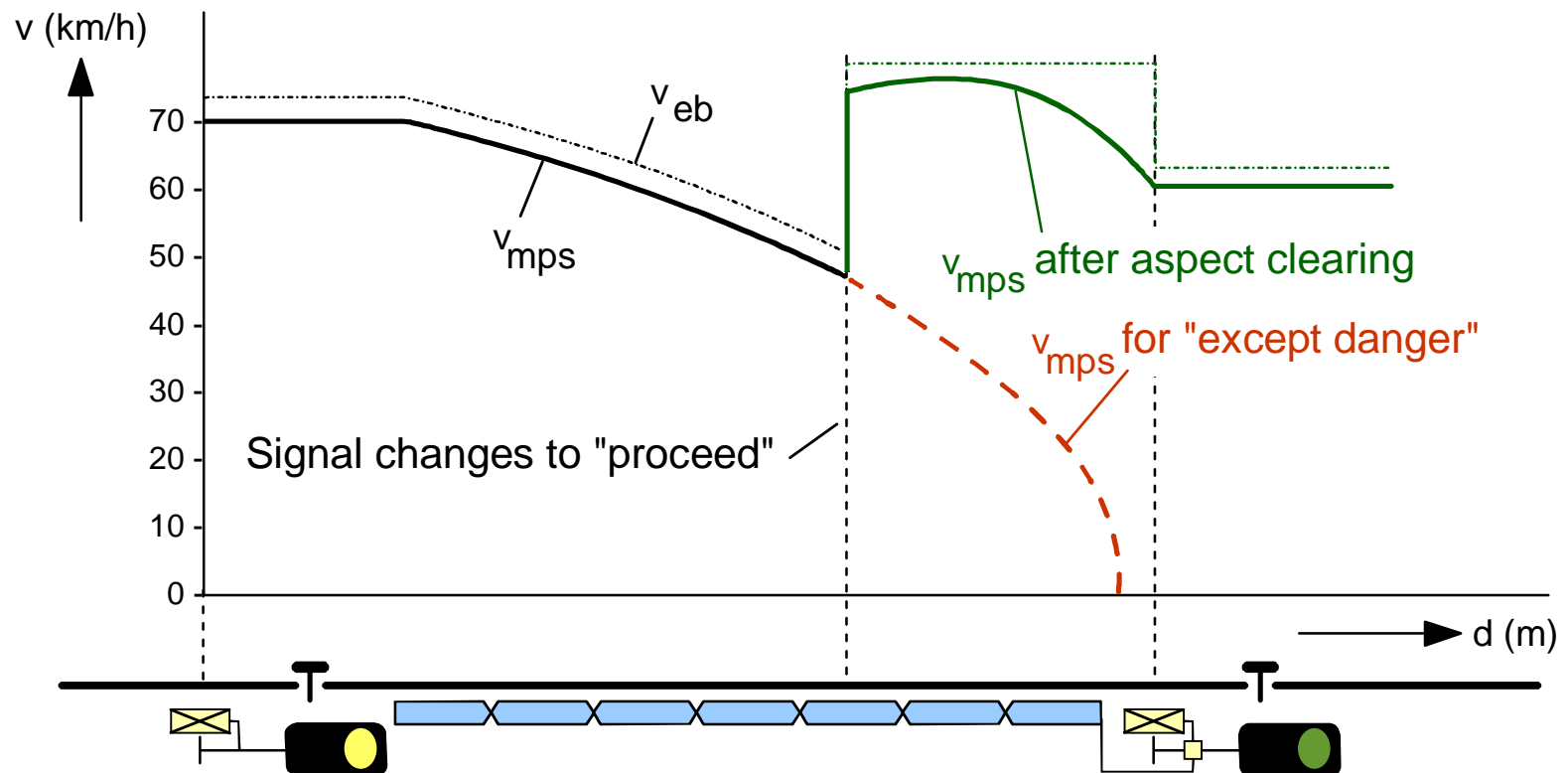
ZUB[®] 200 Automatic Train Control System Monitoring Levels



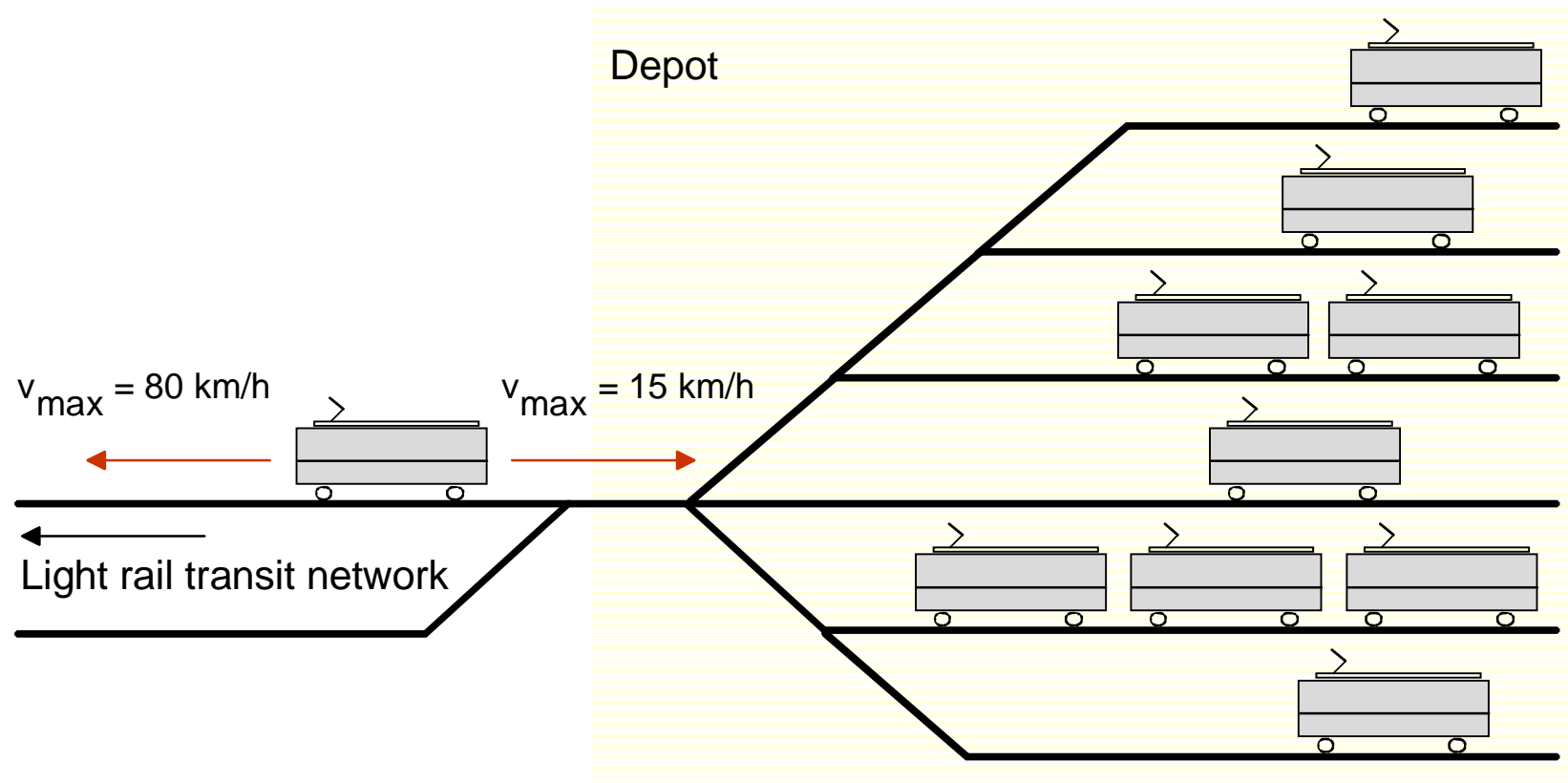
ZUB[®] 200 Automatic Train Control System Monitoring of a Speed Restriction Area (e.g. Building Site)



ZUB[®] 200 Automatic Train Control System Response in Case of Signal Clearing from "Danger" to "Proceed"



ZUB[®] 200 Automatic Train Control System Application Example: Depot



ZUB[®] 200 Automatic Train Control System Technical Data

- Transmission channel
 - Depending on application: 850 kHz, Eurobalise, track circuits, radio, IMU
 - Possible use of aspect-clearing loops for shorter headways
- Maximum speed
 - for transmission via balises ≤ 500 km/h
 - for transmission via track coupling coils ≤ 220 km/h
- Power consumption on-board unit
 - approx. 100 W (depending on components fitted)
- Ambient temperature range
 - -25 °C to +55 °C
- Air gap
 - 130 mm to 195 mm (for system lateral deviation of ± 50 mm)

ZUB® 200 Automatic Train Control System Standards

- Electromagnetic compatibility
 - In accordance with IEC 571-1 and EN 50 155
 - In accordance with EN 50 081-2 EMC emission (March 1994)
 - In accordance with EN 61000-6-2 EMC interference immunity (October 2001)

- Proof of safety
 - Requirement category 6 in accordance with DIN V 19 250
 - Safety integrity level 2 or 3 in accordance with CENELEC standard EN 50 128