SIEMENS

ZUB and Vehicle Coupling Coil (VCC)

User Manual

FCC WARNING

a. Parts of this device have been tested and found to comply with the limits of Part 18 of the FCC rules.
b. Parts of this device have bene tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 subpart B of the FCC rules.

These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

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1. Information for the users

1.1. Introduction

The User Manual contains all essential information for the user to make full use of the ZUB and Vehicle coupling coil (VCC) system. This manual includes a description of the system functions and capabilities, contingencies and step-by-step procedures for system access and use.

1.1.1. Scope

This document describes ZUB and Vehicle coupling coil (VCC).

1.1.2. Purpose

This document describes the features, benefits, structure, and function of the ZUB and Vehicle coupling coil (VCC) system.

1.2. Acronyms and Abbreviations

Table 1: Acronyms and Abbreviations

Acronym / Abbreviation	Description
ATP	Automatic Train Protection
CPU	Central Processing Unit
CRC	Cyclic Redundancy Check
TCC	Track Coupling Coil
TGMT Zub	Trainguard Mass Transit Zub vehicle equipment
IMU*	Induktive Meldungsuebertragung (Inductive message transmission)
On-board equipment	Zub on-board unit including the Zub peripheral components such as vehicle coupling coils and train operator's cab equipment
On-board unit	Central mounting frame for Zub system in 2-out-of-2 configuration with processing, power supply and peripheral boards
VCC	Vehicle Coupling Coil
VE6*	CPU board of the platform
Zub*	Train control system from Siemens

*German abbreviation

1.3. References

1.3.1. Input documents

This table contains the input documents for this documentation.

Table 2: Input documents

Reference Number	Reference Title	Document ID / Source
[1]	ATP TGMT Zub Installation specific configuration data vehicle	A6Z00042673577, A

1.3.2. Other valid documents

This table contains further valid documents.

Table 3: Other valid documents

Reference Number	Reference Title	Document ID / Source
[2]	ATP TGMT Zub Wayside System Design Specification	A6Z00041284205, *
[3]	ATP TGMT Zub Component overview vehicle	A6Z00039577687, *
[4]	List of equipment ATP TGMT Zub	A6Z00043692030, *
[5]	ATP TGMT Zub Commissioning Instructions On-board equipment	A6Z00043446692, *

* Note: Always the latest document version is valid

2. Components of Zub On-board Equipment

The following on-board components are part of the system:

- On-board unit (TASSE5, UEBGEN5)
- Vehicle coupling coils (VCC) at the right hand side in each direction of travel for receiving track data.

2.1. Zub On-board unit

The on-board unit is designed as a single-tier 19'' mounting frame and includes the hardware core as well as the peripheral boards and the power supply. The on-board unit contains a fail-safe 2-out-of-2 computer based on the Train Control Computer. Core and peripheral boards are interconnected by means of an internal bus.

The core element of the Zub central unit is the Train Control Computer core that is implemented in a 2-out-of-2 configuration.

In case of a fault, e.g., loss of synchronicity of both processor channels, the processing is stopped (processor channel stop) and the peripheral components are switched to a safe state (permanent application of emergency brake). The communication of the Train Control Computer with the peripheral components occurs via special interface boards:

Table 4: On-board unit interface boards

Slot#	Definition
1	VE6, processing unit (central board) with RJ45 LAN interface, connector -K11-X2, for loading of the application software
8	TASSE5, telegram detection and recording board with Sub-D-15 connector -T62-X2 for connection of the vehicle coupling coil
9	UEBGEN5, generator and monitoring board with male connector -T61-X2 for connection of the vehicle coupling coil
13	SV5, power supply board with connector -T71-X1 for system activation and connector -T71- X2 for power supply (connection to the on-board voltage)

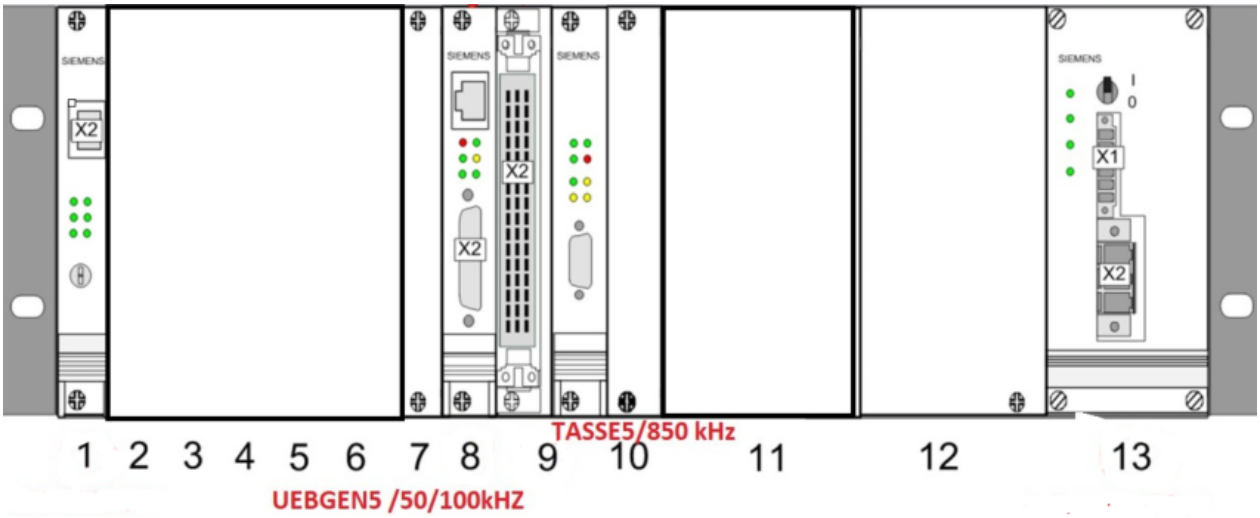


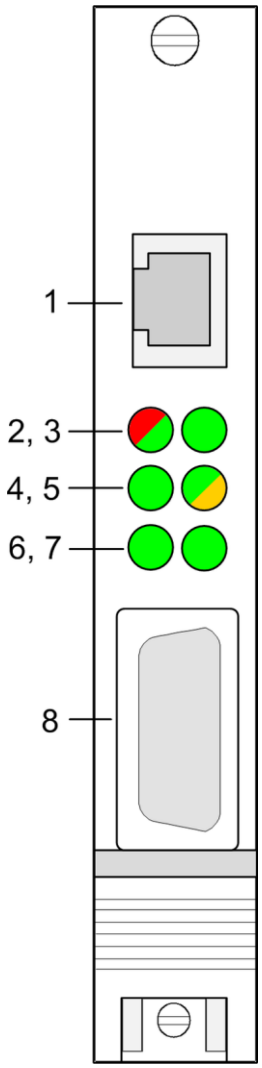
Figure 1: Zub on-board unit

2.1.1. TASSE5 functions and structure

The TASSE5 is a telegram detection and recording board with a FIFO (First In First Out) memory as well as a transmit and receive mode switchover function. Together with the UEBGEN5 board, it is part of the Zub transmission channel. A maximum of two vehicle coupling coils, one per direction of travel, can be connected via the front connector. Power supply of the vehicle coupling coils is short-circuit-proof (current limitation).

The board receives 850-kHz telegrams via the vehicle coupling coil. It transmits 850-kHz telegrams in half-duplex mode via the vehicle coupling coil. Using a direction-of-travel selector, the supply voltage and transmit and receive mode are switched over between the two vehicle coupling coils.

The board demodulates, checks, and stores the track telegrams received from the vehicle coupling coil. Telegrams to be transmitted are loaded into a transmit FIFO memory, modulated, and forwarded to the vehicle coupling coil. The front panel features a 15-pin male connector for front connectors (-T62-X2).



Item	Designation	Explanation	State in normal operation
1	Ethernet interface	Diagnostic interface	
2	TX LED	Steady green light: transmit mode. Steady red light: error	Steady green light
3	RX LED	Steady green light: receive mode	Steady green light
4	ST LED	Steady green light: telegram start detected	Steady green light
5	PB LED	Steady green light: internal test mode Steady orange light: external test mode	Steady green light
6	FA LED	Steady green light: direction of travel A	Steady green light
7	FB LED	Steady green light: direction of travel B	Steady green light
8	-T62-X2: Sub-D-15 connecter	Port for connection of vehicle coupling coil	

Figure 2: Front panel of the TASSE5

2.1.2 UEBGEN5 functions and structure

The UEBGEN5 generator and monitoring board consists of two sub-boards, a generator board, and a generator monitoring board. Together with the TASSE5 board, it is part of the Zub transmission channel. A maximum of two vehicle coupling coils, one per direction of travel, can be connected via the front connector.

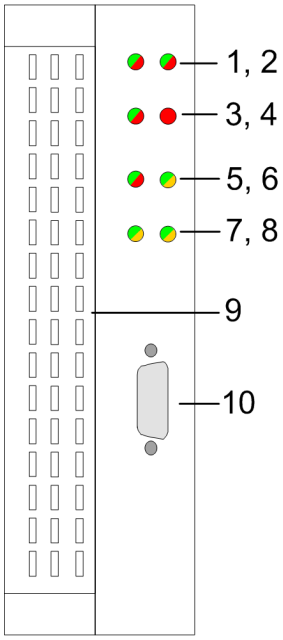
The generator board feeds the vehicle coupling coils with 50 kHz and 100 kHz signals depending on the direction of travel. The generator monitoring board

monitors this generator function and detects the presence of a track coupling coil from its influence on the 50 kHz signal (frequency monitoring).

The output stages are protected against overloading by an overcurrent circuit-breaker which can be reset by the computer via a reset circuit.

The function of the 50 kHz and 100 kHz amplifiers and influence on the 50 kHz circuit are indicated by means of LEDs.

Front panel:



Item	Designation	Explanation	State in normal operation
1	I50 LED	Steady green light: 50 kHz current is OK. Steady red light: 50 kHz current is faulty. The LED shows a steady green light if the board functions correctly and the 50 kHz circuit is not influenced. If the vehicle is pulled by another one, the LED remains off.	Steady green light
2	I100 LED	Steady green light: 100 kHz current is OK. Steady red light: 100 kHz current is faulty	Steady green light
3	R/E LED	Steady green light: normal operation (Run) Steady red light: error (TCC error LED)	Steady green light

Item	Designation	Explanation	State in normal operation
4	FI LED	Off: no overcurrent Steady red light: 50 kHz and 100 kHz output stages are switched off (overcurrent shutdown). The reason is that the resonant current in the 50 kHz circuit has exceeded 350 mA or the current in the 100 kHz circuit has exceeded 3.5 A. This fault condition can be due to a short-circuit on the cable to the coupling coil or both coupling coils are activated due to a fault.	Off
5	24V LED	Steady green light: 24 V supply voltage is OK. Steady red light: undervoltage	Steady green light
6	FUE LED	Steady green light: driver's cab is activated. Steady orange light: • When a track coupling coil is passed, if the current reduction cannot be detected or • if no vehicle coupling coil is connected or • during antenna calibration.	Steady green light
7	FUEA LED	Steady green light: with activation of driver's cab A until activation of driver's cab B. Steady orange light: • When a track coupling coil is passed in the direction of travel A, if the current reduction cannot be detected or • if no vehicle coupling coil is connected or activated or • during antenna calibration.	Steady green light
8	FUEB LED	Steady green light: with activation of driver's cab B until activation of driver's cab A. Steady orange light: • When a track coupling coil is passed in the direction of travel B, if the current reduction cannot be detected or • if no vehicle coupling coil is connected or activated or • during antenna calibration or • no driver's cab B exists (unidirectional vehicle).	Steady green light
9	-T61-X2: 48-pin male connector	Front connector for connection of vehicle coupling coil	
10	Sub-D-9 connector	Serial interface for manufacturer's diagnostics	

Figure 3 Front panel of the UEBGEN5

2.2. Zub vehicle coupling coil

The vehicle coupling coil for the forward direction is the interface to the Zub on-board equipment for data exchange from the track to the vehicle via the air gap.

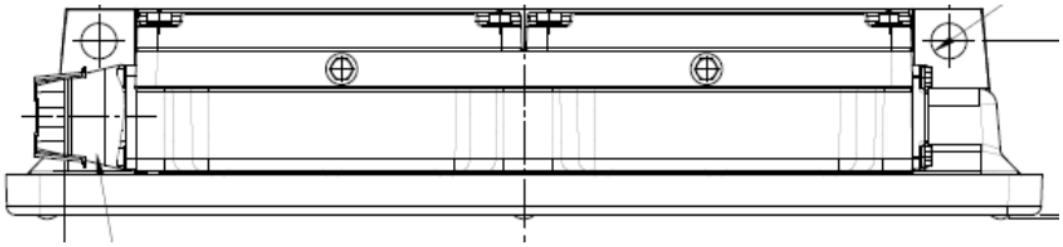


Figure 4: Zub Vehicle Coupling Coil

The transmission system uses the resonances of coupled resonant circuits with different frequencies for communication via the air gap between the on-board and trackside equipment.
The telegrams are received respectively transmitted via the frame antenna of the vehicle coupling coil.

2.3. On-board communication with Vehicle coupling coil (VCC) and Track coupling coil (TCC)

The vehicle coupling coil is connected to the UEBGEN5 generator board and the TASSE5 transceiver board. The vehicle coupling coil is used for bidirectional data transmission between the track and the train.

The UEBGEN5 generator board and the vehicle coupling coil act together to form the 50 and 100 kHz circuits, whereas the TASSE5 board contains the 850 kHz telegram interface.

- 50 kHz control circuit: coupling coil and UEBGEN5 board
- 100 kHz energy transmission circuit: coupling coil and UEBGEN5 board
- 850 kHz data receiving circuit: coupling coil and TASSE5 board

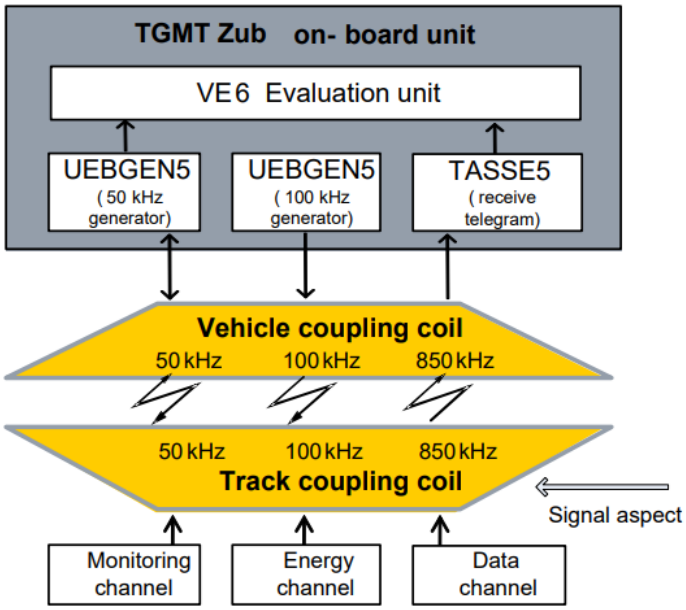


Figure 5: Zub vehicle coupling coil (coupled with track coupling coil)

Besides receiving data from a Track coupling coil as shown in the figure above the Zub on-board unit can also send information via the TASSE5 board containing the 850 kHz telegram interface to an IMU antenna in the track. Therefore, the antenna is periodic switched between receiving and sending while receiving has the higher priority. Indicating information can be forwarded to the control center via Trainguard IMU 100 or the Z-Radio channel.

In case of sending data to the trackside the 850 kHz data circuit works as transmission circuit via TASSE5 board and the vehicle coupling coil.

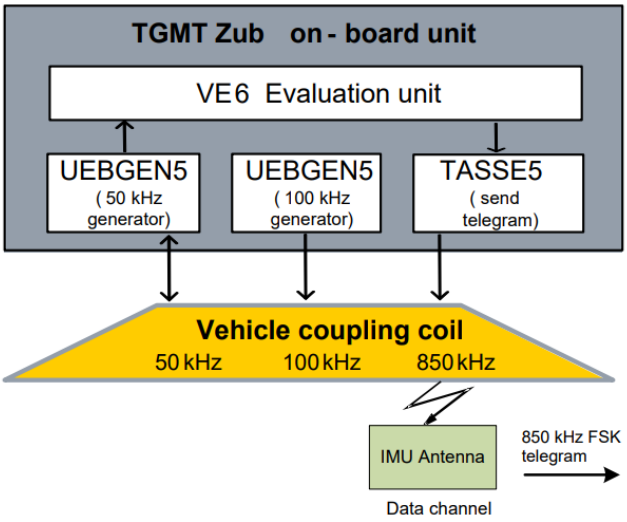


Figure 6: Zub vehicle coupling coil (sending to IMU antenna)

3. Data transmission

The data transmission from the track to the vehicle via coupling coils and radio is used for the safe transmission of the maximum line speed, the signal aspects, and the speed restriction area information to the Zub on-board equipment.

The data transmission from the vehicle to the trackside IMU-device via the Zub vehicle coupling coil is not required for the train protection functionality. It only serves the non-vital transmission of vehicle data to the track side equipment.

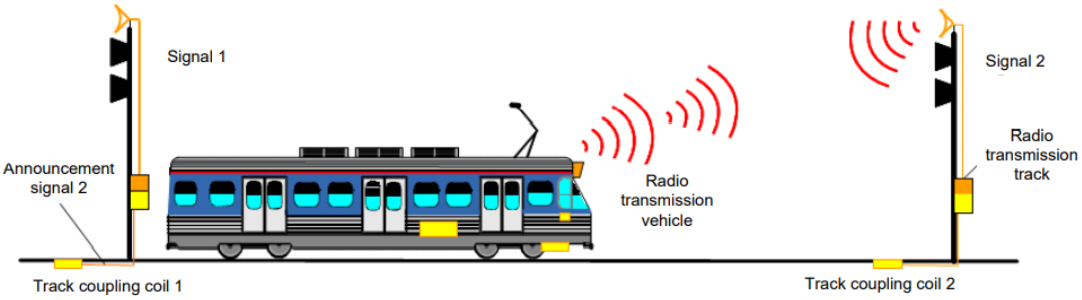


Figure 7: Principle of data transmission

3.1. Data transmission through inductive coupling

The transfer of information between the wayside and vehicle equipment takes place inductively.
In order to enable failure detection for safety reasons, a two-circuit transmission system (50 and 850 kHz circuit) is used for track coupling coils.
Both signal circuits in the track coupling coil are entirely independent of each other, so that a failure of one circuit can be safely detected by the Zub on-board equipment.

- 50 kHz circuit: When a train passes, inductive coupling increases the effective resistance of the vehicle coupling coil. This results in a drop of current intensity in the 50 kHz control circuit on the passing vehicle, which is evaluated by the Zub on-board equipment as the detection of the presence of a track coupling coil.
- 100 kHz circuit: During the passing, the track coupling coil inductively draws the energy necessary for data transmission from the 100 kHz energy transfer circuit of the vehicle coupling coil.
- 850 kHz data transmission channel: The 850 kHz data transmission circuit transmits the track information in the form of telegrams to the vehicle and train information in the form of telegrams to trackside equipment.

The telegrams are transmitted serially from vehicles to wayside and from wayside to vehicles using the half duplex procedure. They contain an identifier to distinguish the transmission directions.

The binary-coded data is transmitted in telegrams with a maximum of 104 usable bits in the frequency range around 850 kHz by means of FSK using a data rate of 50 kBd. The code-checked telegrams are decoded by evaluation logic and made available for further processing.

3.1.1. 850 kHz telegrams track to train

The contents of the telegrams are protected against undetected corruption in several ways. Each individual telegram is protected by means of an error detection suffix (CRC). The CRC check procedure is used to check the received telegrams.

The telegrams are transmitted alternately from the track from two sources. The telegrams from both sources are identical in terms of contents, but they may be identified on the vehicle by a different ID.

In the on-board unit, only information is accepted as valid from a track coupling coil for which correctly coded telegrams from both data sources of the trackside equipment with identical content are present. During the period of receiving track telegrams no vehicle telegrams are sent.

- 850 kHz train to track: Vehicle telegrams are cyclical transmitted via the frame antenna of the vehicle coupling coil. After the transmission, a sniffing period is implemented to check if there are track to train telegrams present.

3.2. Transmission faults (Zub Channel)

Although the Zub transmission channel is inured to disturbances, transmission faults cannot be excluded. The following situations of a data transmission are categorized as transmission faults:

- Correct telegrams are received, but the 50 kHz control channel is missed.
- 50 kHz control channel is detected, but no telegrams are received.
- Only incorrect telegrams are received.
- The received linking information of track coupling coils is wrong.
- The distance of interconnection between track- and vehicle coupling coil is too long.

In case of a transmission fault the TGMT Zub on-board unit reacts according to the actual operating state.

4. General Technical Conditions

4.1. Ambient conditions

4.1.1. Power supply

The TGMT Zub on-board equipment is designed for an input voltage of 24V DC. The power consumption of the TGMT Zub on-board equipment is approx. 150 W.

4.1.2. Ambient Temperature

The operating temperature range for the TGMT Zub on-board equipment inside the vehicle is -13°F to +158°F (-25…+70°C) and outside of the vehicle (vehicle coupling coil) -40°F to +158°F (-40…+70°C). Owing to the enclosed installation of the on-board unit, the ambient temperature must be between -13°F to +131°F (-25…+55°C) in order to guarantee observance of the maximum temperature of +158°F (+70°C) in the interior.
The TGMT Zub on-board equipment complies with [EN 50155].

4.1.3. Humidity

The following humidity stresses apply in the installation room of the signal boards:
According to [EN 50155] the following moisture resistance requirements are met by the compartment housing the TGMT Zub on-board unit:
• Annual average = 75% rel. humidity
• 30 days in the year continuously 95% rel. humidity
The installation of the on-board equipment ensures that these limit values are not exceeded.

4.1.4. Degree of protection

The TGMT Zub on-board unit will be installed in a cabinet with rating IP54 [IEC 60529]. The vehicle coupling coils and the radio antenna comply with the rating IP67 [IEC 60529]. The rest of the housing complies with rating IP42 [IEC 60529].

4.1.5. Altitude

The TGMT Zub on-board unit is designed for altitudes up to 4,593 ft (up to 1400 m) above sea level and hence meets the requirements of [EN 50155].

4.1.6. External Shock and Vibration

The TGMT Zub on-board equipment complies with the vibration and shock loads in accordance with [EN 50155].
The mechanical stress occurring at the installation sites for the various units of on-board equipment must not exceed the values stated in the standard.

4.1.7. Limit values

The reliability of the TGMT Zub on-board equipment is not impaired if the permitted limit values are reached briefly. Constant or long-term operation at the limit values or beyond the limit values results in reduced reliability and is not permitted.

4.1.8. EMC conditions

The components of the TGMT Zub on-board equipment fulfills the standards [2004/108/EC] and [2006/95/EC], [1999/5/EC].
The TGMT Zub on-board unit satisfies EMC requirements to the standard [EN 50121-3-2] Product standard.
The compartment accommodating the TGMT Zub on-board unit meets these conditions, so that on the one side the TGMT Zub on-board unit is unaffected by interference and on the other side does not exceed the permitted values as an active source of interference.

4.1.9. Earthing / shielding / cable laying

Appropriate installation of the components and the observance of the necessary measures regarding earthing and shielding, in addition to the requirements concerning the laying of cables, are prerequisites of compliance with the EMC properties evaluated.

4.1.10. RF Exposure

The use and installation of the Vehicle Coupling Coil underneath a light rail / transit vehicle limits personnel access to the radiating structure of the coil. In order to com ply with the FCC Radio Frequency Radiation Exposure Limits defined in 1.1310(d) (2) the VCC must be installed as specified by the manufacturer. The installation will provide for a minimum separation distance of 40 cm (15.748”) between the VCC and operators or the general population in normal operation.

5. Corrective maintenance

This section describes the entire corrective maintenance of the equipment.

5.1. Replacement of vehicle coupling coil

Removal of vehicle coupling coil:

The vehicle coupling coil (VCC) includes the passive elements of the 50 kHz and 100 kHz circuits and a bidirectional amplifier for the transmit and receive directions of the 850 kHz circuit. A 24V supply voltage with cyclically changing polarity is superimposed on the 850 kHz cable to the vehicle coupling coil. For this reason, do not permanently connect these cables to ground for test purposes (vehicle body).

Step	Action
1	Switch off the on-board unit.
2	Remove the locking plate from the connector of the vehicle coupling coil.
3	Undo the connector nut.
4	Remove the connector.
5	Remove the faulty vehicle coupling coil.

Installation of vehicle coupling coil:

Step	Action
1	Install the new vehicle coupling coil as described in the Specifications
2	Insert the connector.
3	Tighten the connector nut (width across flats 46, 29.5 ft-lb (40 Nm)) using a torque wrench.
4	Lock the connector nut using the locking plate.
5	Perform the following checks and tests: • checking of on-board unit function • performance of antenna calibration

5.2. Performance of antenna calibration

Requirements for antenna calibration (vehicle coupling coil):

The following requirements must be met for the antenna calibration of the vehicle coupling coil:

- The vehicle must have been in an area with an ambient temperature between 14 °F (-10 °C) and 104 °F (+40 °C) for at least one hour before

antenna calibration. During antenna calibration, the ambient temperature must also be between 14 °F (-10 °C) and 104 °F (+40 °C).

- A waiting time of five minutes must be adhered to between re-activation of the on-board unit and antenna calibration.

- When measuring the resonant currents, there must be no interference from a track coupling coil or iron masses (e.g., a set of points) underneath the vehicle coupling coil. In accordance with the operating conditions, the iron-free space is to be min. 38.1” (967.44 mm) to the right and left of the vehicle coupling coil and 50.8” (1290.32 mm) in front of and behind the vehicle coupling coil and extend downwards as far as the sleepers.

Performance of antenna calibration steps:

Step	Action
1	Perform antenna calibration using the fail-safe data input procedure with ZubD Diagnostic program

5.3. Checking of LED indications on TASSE5 board

Checking of LED indications:

Step	Action	
1	Check the LED indications on the front panel of the TASSE5 board.	
	If ...	Then ...
	All LEDs are off.	1. Check the SV5 board 2. Replace the TASSE5 board
	The TX LED shows a steady red light.	Replace the TASSE5 board
	The RX and ST LEDs are off although a track coupling coil is present.	1. Check the cabling between the TASSE5 board and the vehicle coupling coil. 2. Replace the TASSE5 board 3. Check on the UEBGEN5 board whether the I100 LED shows a steady green light 4. Replace the vehicle coupling coil 5. Replace the termination panel.

5.4. Checking of LED indications on UEBGEN5 board

Checking of LED indications:

<table>
<tr><th>Step</th><th>Action</th></tr>
<tr><td>1</td><td>Check the LED indications on the front panel of the UEBGEN5 board.
<table>
<tr><th>If ...</th><th>Then ...</th></tr>
<tr><td>The R/E LED shows a steady red light.</td><td>Check the other LED indications on the board.</td></tr>
<tr><td>The I50 LED does not show a steady green light.</td><td>Check the following components and boards:
1. vehicle coupling coil and its connection to the on-board unit.
2. UEBGEN5 board itself.</td></tr>
<tr><td>The I100 LED does not show a steady green light.</td><td>Check the following components and boards:
1. vehicle coupling coil and its connection to the on-board unit.
2. UEBGEN5 board itself.</td></tr>
<tr><td>The FUE LED and, depending on the direction of travel, the FUEA or FUEB LED do not show a steady green light with an uninfluenced vehicle coupling coil.</td><td>Check the following components and boards:
1. vehicle coupling coil and its connection to the on-board unit.
2. UEBGEN5 board itself.</td></tr>
<tr><td>The FUE LED or, depending on the direction of travel, the FUEA or FUEB LED does not show a steady green light with an uninfluenced vehicle coupling coil.</td><td>Replace the UEBGEN5 board.</td></tr>
<tr><td>The FI LED shows a steady red light.</td><td>1. Check the vehicle cabling.
2. To cancel overcurrent switch-off, switch the on-board unit off and on again.</td></tr>
<tr><td>The 24V LED does not show a steady green light.</td><td>Check the SV5 board.</td></tr>
<tr><td>The FUE LED and, depending on the direction of travel, the FUEA or FUEB LED do not show a steady orange light with an influenced vehicle coupling coil.</td><td>1. Check the cabling to the affected vehicle coupling coil for short-circuits.</td></tr>
<tr><td>The FUE LED or, depending on the direction of travel, the FUEA or FUEB LED does not show a steady orange light with an influenced vehicle coupling coil.</td><td>Replace the UEBGEN5 board.</td></tr>
</table></td></tr>
</table>

5.5. Checking of vehicle coupling coil

Checking of vehicle coupling coil:

Step	Action
1	Check whether the vehicle coupling coil is installed within the permissible tolerances of the system clearances (lateral deviation, height above the top of the rail).
2	Check the UEBGEN5 board and the TASSE5 board.
3	Check the cabling.
4	In the case of a fault, replace the complete vehicle coupling coil.

6. FCC Compliance Statement

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

This device complies with Part 18 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation.

If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment to an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Changes or modifications to this product not authorized by Siemens Mobility Inc. could void the electromagnetic compatibility (EMC) and wireless compliance and negate your authority to operate the product.

This product has demonstrated EMC compliance under conditions that included the use of compliant peripheral devices and shielded cables between system components. It is important that you use compliant peripheral devices and shielded cables between system components to reduce the possibility of causing interference to radios, televisions, and other electronic devices.

Responsible party (contact for FCC matters only):

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