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Track Coupling Coil (TCC)
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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	Name	Department	Electronic Signature
Released by	Francesco Mantovani	SMO NAM RC-US RI PSGR PE MGR2	Mantovani Francesco
Formally checked by	Stefan Makuch	SMO NAM RC-US RI QM PRJ	Makuch Stefan nyomast1
Contents checked by	Justin Kibler	SMO NAM RC-US RI PSGR WY A-IXL	Kibler Justin
Author	Vishwanath Badiger	SMO NAM RC-US RI PSGR WY A-IXL	Badiger Vishwanath

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Siemens Mobility, Inc.
One Penn Plaza
New York, NY 10119
USA

www.siemens.com

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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 Track Coupling Coil (TCC) 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 the Track Coupling Coil (TCC), referred to below simply as TCC.

1.1.2. Purpose

This document describes the features, benefits, structure, and function of the Track Coupling Coil (TCC) 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

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2. Zub Track Coupling Coil

The transfer of information between the wayside and on-board 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 in the track coupling coils in order to enable failure detection.

Both signal circuits are entirely independent in the track coupling coil, so that a failure of one circuit can be safely detected by the Zub on-board equipment.

When a train passes, inductive coupling increases the effective resistance of the vehicle coupling coil. This results in a current decrease 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.

During the passing of the vehicle coupling coil (VCC) over the TCC, the track coupling coil inductively draws the necessary energy for data transmission from the 100 kHz energy transfer circuit of VCC.

The 100 kHz are permanently sent by the Zub on-board equipment.

Track coupling coils transmit track data to the vehicle via the data channel in the 850 kHz range.

The track coupling coil contains stored data telegrams, which are transmitted dependent on the signal aspect setting.

- via the 850 kHz transmission channel, and
- via the loop control unit to the ZRadio-Sx module

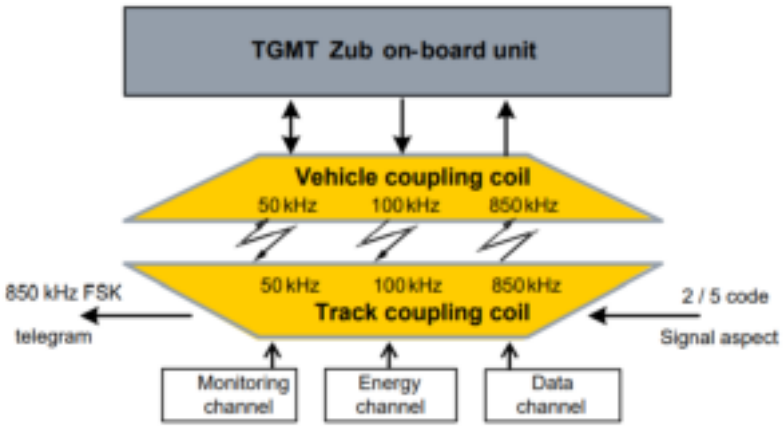

Figure 1: Principle of transmission of the Zub track coupling coil

2.1. Structure of the Track Coupling Coil

Track coupling coils consist of a basic body with installation room for electronic modules. These modules are referred to as telegram memory modules. The basic body of the track coupling coil contains a 50 kHz control resonant circuit, a 100 kHz supply circuit, including the downstream power supply, and the output amplifier of the 850 kHz circuit.

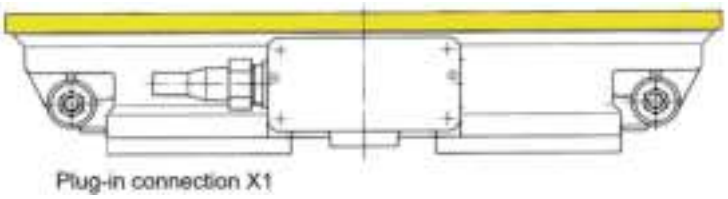

Figure 2: Zub basic track coupling coil

The 2-out-of-5-coded signal information is transmitted via a 6-pole plug-in connection (see Figure 2, Plug-in connection X1) from the signal interface. In the case of permanently coded track coupling coils, a coding plug with cover is installed at this point.

The track coupling coil version for radio modules has a second 6-pole plug-in connection (see Figure 3, Plug-in connection X2), via which the connection to the radio module is established.

An installation compartment accessible via a removable cover is located in the track coupling coil (see Figure 4). The installation compartment houses four replaceable canned units comprising the telegram control unit (modulator), the duplicated telegram store units of the 850 kHz data channel and, in version with a radio module, the loop control unit (interface to the radio module).

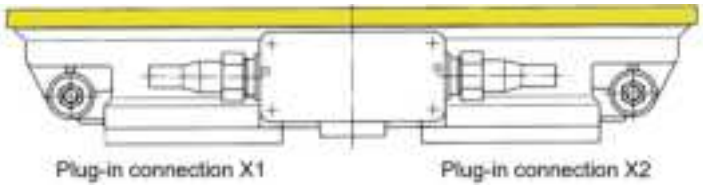

Figure 3: Zub track coupling coil for radio-infill

2.2. Modules of the Track Coupling Coil

2.2.1. Telegram Memory Modules of the Track Coupling Coil

The telegram memory module contains the different, pre-configured telegrams depending on the signal aspect. Telegrams are selected by the 2-out-of-5 code of the signal interface.

2.2.2. Zub Transmission Control Unit

The transmission control unit activates the two telegram store units alternately and converts the data telegram selected by the signal code via a binary frequency shift keying (FSK) modulation into 850 kHz (823.5 kHz and 875 kHz).

2.2.3. Zub Loop Control Unit

The Zub loop control unit is only used for track coupling coils with a radio module ZRadio-Sx. It acts as the interface between them and transmits the modulated telegrams from the transmission control module to the radio module.

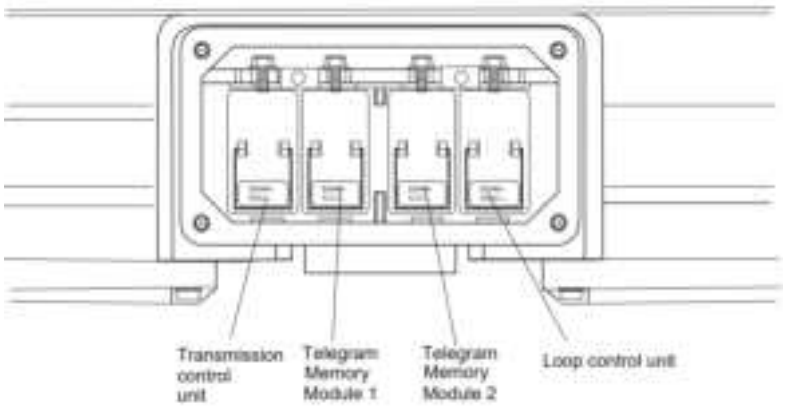

Figure 4: Installation room of the track coupling coil with arrangement of the canned units

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.

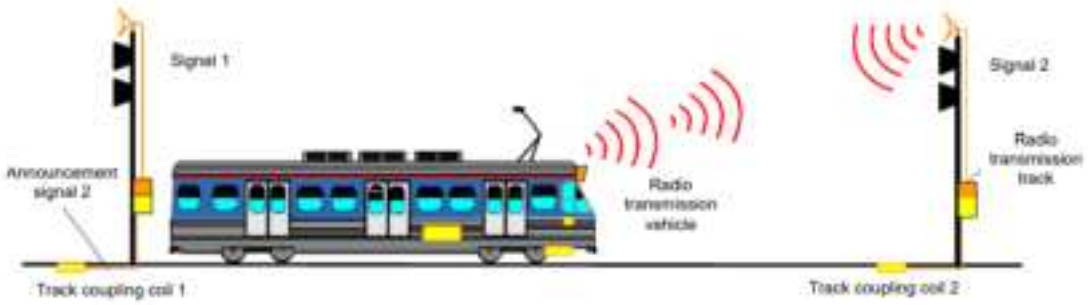

Figure 5: Principle of data transmission

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 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 track coupling coils receive their power inductively from the passing vehicle coupling coil or via the radio module for radio infill.

4.1.2. Ambient Temperature

On account of the low power consumption during operation no significant heat dissipation occurs. For the TGMT Zub wayside equipment, the following ambient temperature ranges are defined:

- Track coupling coil: -22°F to +131°F (-30°C…+55°C)

In order to ensure correct functionality, this temperature range must be observed, i.e., the ambient temperature must be within this range.

The TGMT Zub wayside equipment complies with [EN 60068-2]

- Part 2-1: Tests - Test A: Cold
- Part 2-2: Tests - Test B. Dry heat
- Part 2-14: Tests - Test N: Change of temperature

4.1.3. Humidity

The following humidity stresses apply in the installation room of the signal boards:

- Annual average = 75% rel. humidity
- 30 days in the year continuously 95% rel. humidity
- On the remaining days occasionally 85% relative humidity
- Infrequent and light condensation

These values comply with [EN 60068-2]

- Part 2-30: Tests - Test Db: Damp heat, cyclic.

The above-mentioned operation related infrequent and light condensation causes no malfunctions or failures.

4.1.4. Degree of protection

Track coupling coil and the radio antenna comply with the rating IP67 [IEC 60529].

4.1.5. Altitude

The TGMT Zub wayside equipment is designed for altitudes of -1,312 ft to +6,562 ft (-400 m to +2,000 m) above sea level and thus conforms to the Standard [EN 50125-3].

4.1.6. External Shock and Vibration

The wayside equipment withstands the mechanical stresses occurring at the installation site without any functional impairment and without any change in its operating position.

The TGMT Zub wayside equipment complies with the vibration and shock loads in accordance with [EN 60068-2]

- Part 2-6: Tests - Test Fc: Vibration (sinusoidal)
- Part 2-64: Tests - Test Fh: Vibration, broadband random
- Part 2-27: Tests - Test Ea and guidance: Shock (ZRadio-Sx; TCC)

The mechanical stress occurring at the installation sites for the units of the TGMT Zub wayside equipment must not exceed the values stated in the standard.

4.1.7. Limit values

The reliability of the TGMT Zub wayside 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 wayside equipment fulfill the directives [2004/108/EC] and [2006/95/EC], [1999/5/EC].

The TGMT Zub wayside equipment satisfies the EMC requirements of the standard [EN 50121-4] Product standard.

4.1.9. Earthing and lightning protection

Earthing and lightning protection has to be done according to the project wide Earthing Concept.

5. Inspection and preventive maintenance

Inspection and preventive maintenance of the wayside equipment must be performed in line with the schedule below. The inspection and preventive maintenance work have to be performed with due care. The date of inspection, preventive maintenances, all detected deficiencies, and their rectification must be documented.

5.1. Inspection and preventive maintenance schedule

Table 4: Inspection and preventive maintenance intervals

Task No.	Object	Interval	Activity
1	All components	Every 30 years	Visual inspection and, if required, cleaning Checking of all components and cables for mechanical damage and of connectors for a secure fit and any leaks.
2	Transmission of track coupling coil	Every 30 years	Checking for correct transmission of all signal aspects (see below)
3	Spare boards (incl. TCC modules)	Every 30 years	Replacement of spare boards (see below)
4	Track coupling coil	Every two (2) years	Replacement of spare track coupling coil (see below)

5.1.1. Details relating to task 2: transmission of track coupling coil

All safety-related components must be checked (correspondence checking) from activation of the signal aspect at the interlocking and the lamp until output of the information via the track coupling coil. For this purpose, the Zub track tester is used to activate all signal aspects to be checked at the relevant transmission point and to read out the track coupling coil information via the air gap.

During read-out, the Zub track tester automatically tests operation of the 50 kHz and 100 kHz circuits of the track coupling coil. The telegram information selected, based on the activated signal aspect, and transmitted, is code checked. In addition, the telegram contents of the two telegram memory modules of the track coupling coil are compared to establish whether they are identical. Any errors are displayed by means of error codes on the Zub track tester.

In addition, it must be checked that the contents of the transmitted telegram correspond to the activated signal aspect.

5.1.2. Details relating to task 3: spare boards

Functional integrity of the stored spare boards does not need to be checked.

Spare boards must be stored at a temperature of below 104°F. At higher temperatures, the formation of the electrolytic capacitors is lost faster.

5.1.3. Details relating to task 4: track coupling coil

Functional integrity of the stored track coupling coils does not need to be checked.

The spare track coupling coils must be replaced every two years by operational track coupling coils to preserve the formation of the electrolytic capacitors.

Spare boards have to be stored at a temperature of below 104 °F. At higher temperatures, formation of the electrolytic capacitors is lost faster.

5.1.4 RF Exposure

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

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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):

Siemens Mobility, Inc.
One Penn Plaza
New York, NY 10119
USA

www.siemens.com/contact