European Railway Agency

Guide for the application of the TSI for the Subsystems Control-Command and Signalling Track-side and On-board

According to Framework Mandate C(2007)3371 final of 13/07/2007

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AMENDMENT RECORD

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1.0 24/02/2012	ERA ERTMS Unit	1.1; Table 1	Reference to the published CCS TSI
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1. INTRODUCTION

1.1. SCOPE

1.1.1. This document is an annex to the “Guide for the Application of TSIs”. It provides information on the application of Technical Specification for Interoperability for “Control-Command and Signalling” adopted by Commission Decision 2012/88/EU.

1.1.2. This document needs to be read and used only in conjunction with the “Control-Command and Signalling” TSI. It is intended to facilitate its application but it does not substitute for it. The general part of the “Guide for the Application of TSIs” has also to be considered.

1.1.3. Guidance is of voluntary application. It does not mandate any requirement in addition to those set out in the “Control-Command and Signalling” TSI.

1.2. DOCUMENT DESCRIPTION

1.2.1. Chapter 3 provides clarifications for certain concepts and requirements of the Control-Command and Signalling TSI. To facilitate the use, this chapter has the same structure as the TSI: each section of chapter 3 refers to a section of the TSI.

1.2.2. Guidance is not provided where the “Control-Command and Signalling” TSI does not requires further explanations.

1.2.3. Chapter 4 lists the specifications and standards supporting the assessment of compliance with the TSI requirements. The scope of each standard is clarified through the reference to the corresponding basic parameter.

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2. REFERENCES, TERMS AND ABBREVIATIONS

2.1. REFERENCE DOCUMENTS

Table 1: Reference documents

Ref. N°	Document Reference	Title	Last Issue
[1]	2012/88/EU	Commission Decision of 25 January 2012 on the technical specification for interoperability relating to the control-command and signalling subsystems of the trans-European rail system	*OJ L 51, 23.2.2012 p. 1*
[2]	2004/49/EC	Directive 2004/49/EC of the European Parliament and of the Council of 29 April 2004 on safety of the Community's railways	29 April 2004
[3]	2008/57/EC	Directive 2008/57/EC of the European Parliament and of the Council of on the interoperability of the the rail system within the Community	17 June 2008
[4]	2004/108/EC	Directive 2004/108/EC of the European Parliament and of the Council of 15 December 2004 on the approximation of the laws of the Member States relating to electromagnetic compatibility	15 December 2004
[5]	1999/5/EC	Directive 1999/5/EC of the European Parliament and of the Council of 9 March 1999 on radio equipment and telecommunications terminal equipment and the mutual recognition of their conformity	9 March 1999
[6]	2011/C 288/01	Commission communication in the framework of the implementation of Directive 2004/108/EC of the European Parliament and of the Council of 15 December 2004 on the approximation of the laws of the Member States relating to electromagnetic compatibility and repealing Directive 89/336/EEC	*OJ C 288, 30.9.2011 p. 1*
[7]	2011/C 214/02	Commission communication in the framework of the implementation of the Directive 2008/57/EC of the European Parliament and of the Council of 17 June 2008 on the interoperability of the rail system within the Community (recast)	*OJ C 214, 20.7.2011 p. 54*
[8]	ERA_ERTMS_0001	ERTMS Change Control Management	2.0
[9]	ERA_ERTMS_028528	Terms of Reference of the "Notified Bodies ad hoc Group for ERTMS"	1.0
[10]	2011/217/EU	Commission Recommendation of 29 March 2011 on the authorisation for the placing in service of structural subsystems and vehicles under Directive 2008/57/EC of the European Parliament and of the Council	29 March 2011
[11]	2011/C 277/01	Commission communication in the framework of the implementation of the Directive 1999/5/EC of the European Parliament and of the Council of 9 March 1999 on radio equipment and telecommunications terminal equipment and the mutual recognition of their conformity	*OJ C 277, 21.9.2011 p. 1*
[12]	ECC/DC(02)O5 as amended 8 March 2013	ECC Decision of 5 July 2002 on the designation and availability of frequency bands for railway purposes in the 876 – 880 and 921 – 925 MHz bands	
[13]	ERA/TD/2009-02/INT	List of fully approved K composite brake blocks for International transport	4.0
[14]	ERA_ERTMS_040001	Assignement of values to ETCS variables	1.4

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2.2. TERMS & ABBREVIATIONS

Table 2: Terms and abbreviations

Abbreviation	Definition
CCS	Control-command and Signalling
EMC	Electromagnetic compatibility
ERATV	European Register of Approved Types of Vehicles
ERTMS	European Rail Traffic Management System
ETCS	European Train Control System
GSM	Global System for Mobile Communication
GSM-R	GSM for Railways
MS	Member State
NTC	National Train Control
RINF	Register of Infrastructure
STM	Specific Transmission Module
TSI	Technical Specification for Interoperability

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3. CLARIFICATIONS

3.1. FOREWORD

3.1.1. This sections contains clarifications to help readers understanding the TSI Control-Command and Signalling.

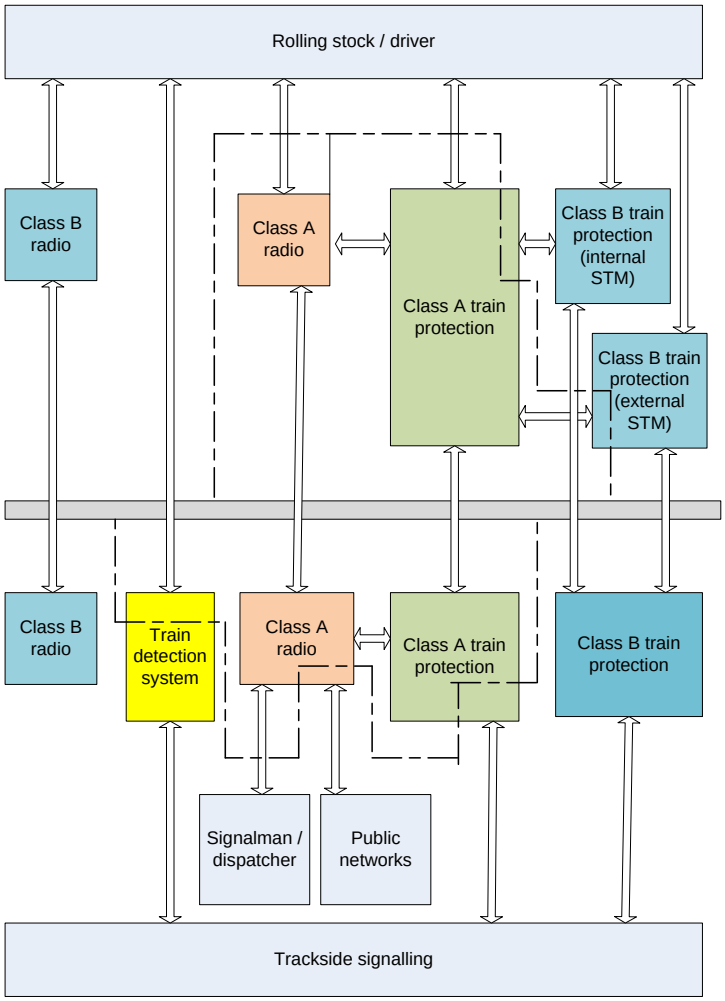
3.1.2. Subjects of clarifications can be added in the future based on return of experience.

3.2. SCOPE OF THE TSI CONTROL-COMMAND AND SIGNALLING

3.2.1. Overview

3.2.1.1. The fig. 1 gives an overview of the scope of the TSI Control-Command and Signalling.

Figure 1: Scope of TSI Control-Command and Signalling



3.2.1.1.1. The picture shows the Control-Command and Signalling subsystems and their interface with rolling stock and operators.

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3.2.1.2. The requirements of the TSI apply to the parts within the dotted line; the grey horizontal line separates Control-Command and Signalling On-board and Trackside subsystem.

3.2.1.3. With reference to the description of the composition of the Control-Command and Signalling subsystems provided in chapter 2 of the corresponding TSI [1], the following considerations should be taken into account.

3.2.2. Scope of TSI Control-Command and Signalling requirements

3.2.2.1. The TSI Control-Command and Signalling does not require full standardisation of all Control-Command and Signalling functions, but only of the ones that are strictly necessary to achieve interoperability while complying with the essential requirements.

3.2.2.2. The TSI Control-Command and Signalling gives harmonised solutions for the functions, performance and interfaces that are relevant for interoperability and makes their implementation mandatory for the on-board (to ensure that vehicles may move uninterrupted throughout the EU) but allows flexibility for their implementation trackside. As a consequence, it is the responsibility of each trackside implementation to define, for example, if shunting operations are allowed/ supervised, if in-fill is required, etc.

3.2.3. TSI Control-Command and Signalling and other regulations

3.2.3.1. Requirements of other European regulations apply to all parts of the Control-Command and Signalling subsystems described in fig. 1, including those within the scope of the TSI Control-Command and Signalling and those outside the scope of the TSI Control-command and Signalling.

3.2.3.2. The TSI Control-Command and Signalling does not address compliance with the requirements of other European regulations. Compliance to other European regulations is specified in the corresponding Directives. This is clarified in chapter 3 of [1] (see also chapter 3.3 of this Application Guide).

3.2.4. ERTMS/ETCS application levels

3.2.4.1. The TSI Control-Command and Signalling allows a choice between the following possibilities for the installation of track-side ERTMS/ETCS:

1. Level 1: intermittent track to train communication;
2. Level 2: continuous track to train and train to track communication;
3. Level 3: as level 2, with train integrity provided on-board.

3.2.4.2. In addition, in the TSI Control-Command and Signalling, level 0 and level NTC are defined for the operation of an ERTMS/ETCS on-board on lines respectively without track-side train protection systems or equipped with legacy systems.

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3.2.5. Migration to interoperability

3.2.5.1. The TSI Control-Command and Signalling requires that Class B equipment is progressively be replaced by Class A equipment.

3.2.5.2. The rules to be followed for the migration are specified in chapter 7 of the TSI Control-Command and Signalling [1]. See section 3.7.2 of this Guide.

3.3. ESSENTIAL REQUIREMENTS

3.3.1. Principles

3.3.1.1. The essential requirements are described in chapter 3 of the TSI Control-Command and Signalling [1], which also provides, for each essential requirement, the link with the corresponding basic parameter(s).

3.3.1.2. The general concept is applied, that compliance with the basic parameters specified in the TSI Control-Command and Signalling ensures that the corresponding essential requirement is respected.

3.3.2. "Safety" and "availability/reliability"

3.3.2.1. The TSI Control-Command and Signalling defines railway specific requirements (i.e., requirements specifically related to design, construction, placing in service, upgrading, renewal, operation and maintenance of the subsystems as well as the professional qualifications and health and safety conditions of the staff who contribute to its operation and maintenance). It does not address general aspects (non "railway specific") of these essential requirements (e.g., product safety, like protection against fulmination), because they are in the scope of other European regulations.

3.3.2.2. As far as railway specific aspects are concerned, the Railway Safety Directive [2] applies to the whole system; it is possible to respect both the Interoperability ([3], [10]) and the Safety Directive [2], because:

1. When designing a new trackside Control-Command and Signalling subsystem or when performing a major modification/upgrade of an existing subsystem where the application of the TSI is required in accordance with the provisions of art. 20 of [3], the risk analysis identifies the functions, performance and interfaces to be implemented trackside in order that the overall safety objective for the railway system can be achieved without any exported requirement to the on-board Control-Command and Signalling subsystems, which might contradict or exceed what is specified in the TSI.
2. When designing a new on-board Control-Command and Signalling subsystem or when performing a major modification/upgrade of an existing subsystem where the application of the TSI is required in accordance with the provisions of art. 20 of [3], the risk analysis identifies the requirements for the installation on the rolling stock, in order that the safety requirements specified in the relevant TSIs are met.
3. The provisions of [2] are applied to prove compliance with the essential requirement "safety" defined in the TSI Control-Command and Signalling, when conformity of Interoperability Constituents is checked and EC verification of trackside and on-board subsystem is performed.

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4. The EC verifications of the trackside and on-board subsystem prove that all the functions, interfaces and performance required in the subsystems on the basis of the analysis described in bullets 1 and 2 above, are implemented and comply with the requirements specified in the TSI.

3.3.3. "Health" and "Environmental protection"

3.3.3.1. According to the principle stated above, the TSI Control-Command and Signalling specifies no requirements or checks in addition to the ones foreseen by the other regulations applicable for the essential requirements "Health" and "Environmental protection".

3.3.4. "Technical Compatibility"

3.3.4.1. The electromagnetic compatibility between the railway system and the "external world" is part of the "Environmental protection" essential requirements and is fully covered by [4] and [5], together with the harmonised standards [6][1] and [11][2].

3.3.4.2. The "Technical compatibility" essential requirement addresses the interferences between equipment inside the railway system.

3.3.4.3. The Directives [4] and [5] (with the support of the harmonised standards [6] and [11]) cover these aspects, with a relevant exception, i.e., the compatibility between rolling stock and trackside Control-Command and Signalling equipment (e.g., track circuits and axle counters); the Control-Command and Signalling TSI defines therefore requirements and verification procedures for this issue.

3.4. BASIC PARAMETERS

3.4.1. Control-Command and Signalling safety characteristics relevant to interoperability (basic parameter 4.2.1)

3.4.1.1. This basic parameter refers to both the essential requirement "safety" and the essential requirement "availability/reliability". In the scope of the TSI Control-Command and Signalling only the availability/reliability aspects that may negatively affect the system safety are taken into consideration.

3.4.1.2. More stringent availability/reliability requirements for commercial reasons are possible, but, being not part of the essential requirement, they can be managed in the context of contracts between IMs and RUs and not as criteria for authorisation to service or to determine technical compatibility or safe integration.

3.4.1.3. The safety requirements for Control-Command and Signalling subsystems are expressed in terms of technical performances (functions, tolerable hazard rates) of equipment.

3.4.1.4. The safety requirements are enough to ensure the safe integration of Control-Command and Signalling subsystems into the railway system, respecting the safety objective for the service, as determined according to the provisions of [2].

[1] *General EMC requirements*

[2] *Requirements specially applicable to GSM-R, Eurobalise and Euroloop*

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3.4.1.5. To achieve interoperability, the TSI requires that every on-board Control-Command and Signalling subsystem fully respects the mandatory requirements. The TSI does not forbid less stringent safety requirements for a track-side Control-Command and Signalling implementation, when they are enough to achieve the safety objective for the service and as far as the safe movement of vehicles equipped with TSI compliant Control-Command and Signalling subsystem is not hindered.

3.4.2. On-board and Track-side ERTMS/ETCS functionality (basic parameters 4.2.2 and 4.2.3)

3.4.2.1. The implementation of certain functions and interfaces specified in the TSI Control-Command and Signalling is optional. These optional functions and interfaces can be used neither as criteria to grant or refuse an authorisation to put into service an subsystem nor to define, limit or specify requirements for technical compatibility or safe integration between on-board and trackside subsystems having an EC Declaration of verification. There are exceptions for some specific conditions, listed in the appropriate sections of chapter 4 and summarised in section 7.2.6 of the TSI Control-Command and Signalling [1] and related to on-board implementation of:

1. In-fill (Euroloop and radio in-fill) in Level 1,
2. Radio data transmission in level 2 and 3,
3. Train integrity supervision on-board in level 3,
4. “K interface” for STM.

3.4.3. Mobile communication functions for railways (basic parameter 4.2.4)

3.4.3.1. No additional clarification necessary.

3.4.4. ERTMS/ETCS and GSM-R air gap interfaces (basic parameter 4.2.5)

3.4.4.1. The TSI specifies technical characteristics of equipment and includes the operational frequency band for the radio communication.

3.4.4.2. To operate GSM-R, it is necessary that MSs allow the use of this frequency band. The most appropriate way is the implementation of the relevant ECC recommendations [12].

3.4.5. On-board interfaces internal to Control-Command and Signalling (basic parameter 4.2.6)

3.4.5.1. No additional clarification necessary.

3.4.6. Track-side interfaces internal to Control-Command and Signalling (basic parameter 4.2.7)

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3.4.6.1. No additional clarification necessary.

3.4.7. Key management (basic parameter 4.2.8)

3.4.7.1. The cryptographic keys are used by the ERTMS/ETCS train to track communication protocol to calculate a code that supports protection against both communication errors and intentional malicious intrusions.

3.4.7.2. The protection against intentional attacks is obtained if the key used to calculate the protection code for the messages is kept confidential.

3.4.7.3. All the technical characteristics of the protocols are completely defined in the mandatory specifications. The requirements for the confidentiality of the keys with respect to risks related to safety of railway operations are not in the scope of the TSI Control-Command and Signalling.

3.4.7.4. The TSI requires the ERTMS/ETCS equipment to comply with the specified interfaces to store, modify and delete keys, while possible requirements for their management are the responsibility of Infrastructure Managers and rolling stock keepers (and determined, for example, by regulations of authorities responsible for the security of the transport systems).

3.4.7.5. Considering that requirements related to security might become an obstacle to the free movement of trains (like it may happen with national safety rules; see art. 8 of [2]), Member States should communicate them to the European Commission, in order to have a coordinated approach.

3.4.8. ETCS-ID management (basic parameter 4.2.9)

3.4.8.1. The procedures for the allocation of variables are specified in [14]. The allocation can be done through the web-site of the Agency: http://www.era.europa.eu/Document-Register/Pages/ETCS-Variables.aspx.

3.4.9. Track-side train detection systems (basic parameter 4.2.10)

3.4.9.1. For this basic parameter the TSI makes reference to the specification in its Annex A, Index 77, which defines the parameters of the interface between the train detection systems (which are part of the Control-Command and Signalling track-side subsystem) and other subsystems.

3.4.9.2. This specification is used by the Control-Command and Signalling TSI to define the interface requirements for the design and installation of train detection systems. It is the responsibility of other TSIs to indicate the requirements for the corresponding subsystems.

3.4.9.3. It has to be noted, that some characteristics of rolling stock, relevant for the compatibility with track circuits, can be specified and checked at the level of a single vehicle, while other apply to the complete consist of more vehicles, like, for example, the impedance between wheels and pantograph (section 3.2.2.1 of Index 77) and are therefore related to the use of vehicles and not to their authorisation to put in service (unless the requirement is also applicable for a single vehicle). The specification

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Index 77 includes a table indicating which subsystem may be affected by any parameter.

3.4.9.4. Special attention is necessary for the “shunting impedance for track circuits” (see also Annex 1 of this Application Guide).

3.4.9.5. As explained there, some of the elements that contribute to the “shunting impedance” can be managed at the level of a single vehicle. The contact resistance between wheel and rail, however, depends on the interaction of several factors both in static (vehicle at standstill) and dynamic conditions (vehicle is running) and this interaction is not yet fully known.

3.4.9.6. In some Member States rules exist, related to the use of composition of vehicles, to ensure that the resulting consist is detected by the track circuits. Being, at the present state, impossible to harmonise these rules, they are indicated as an open point. The following clarifications have to be taken into account:

1. These rules do not involve technical characteristics of vehicles other than the ones already indicated in the specification Index 77, but only refer to the interaction of these characteristics; for this reason the rules do not apply to the authorisation of a vehicle, but only to its use within a consist;

2. The indication of an open point has not the scope of generating new rules, but only to have the existing ones managed in a transparent way, for manufacturer and operators;

3. As with all open points, the Agency expects that the notified rules will contribute to its clarification and closure.

3.4.9.7. For brake blocks, the requirements of the TSI are satisfied by the types `approved` and listed in the corresponding ERA Technical Document [13]. In the future, reference to acceptance procedures will be included in the TSI.

3.4.10. Electromagnetic compatibility between rolling stock and Control-Command and Signalling track-side equipment (basic parameter 4.2.11)

3.4.10.1. For explanations related to electromagnetic fields see Annex 2 of this Application Guide.

3.4.11. ERTMS/ETCS DMI (basic parameter 4.2.12)

3.4.11.1. No additional clarification necessary.

3.4.12. GSM-R DMI (basic parameter 4.2.13)

3.4.12.1. No additional clarification necessary.

3.4.13. Interface to data recording for regulatory purposes (basic parameter 4.2.14)

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3.4.13.1. No additional clarification necessary.

3.4.14. Visibility of track-side Control-Command and Signalling objects (basic parameter 4.2.15)

3.4.14.1. No additional clarification necessary.

3.4.15. Environmental conditions (basic parameter 4.2.16)

3.4.15.1. The mandatory environmental conditions for some equipment (e.g., debris for Eurobalise) are defined in the corresponding specifications.

3.4.15.2. In addition, chapter 6 of the TSI Control-Command and Signalling [1], requires that for each interoperability constituent and subsystem the applicable working conditions are indicated.

3.4.16. Functional and technical specification of the interfaces to other subsystems (4.3)

3.4.16.1. No additional clarification needed.

3.4.17. Operating rules (4.4)

3.4.17.1. No additional clarification needed.

3.4.18. Maintenance rules (4.5)

3.4.18.1. No additional clarification needed.

3.4.19. Professional competences (4.6)

3.4.19.1. No additional clarification needed.

3.4.20. Health and safety conditions (4.7)

3.4.20.1. No additional clarification needed.

3.5. INTEROPERABILITY CONSTITUENTS

3.5.1. Principles

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3.5.1.1. The TSI Control-Command and Signalling specifies a set of “basic interoperability constituents” and allows their “grouping” to allow flexibility for development and implementation.

3.5.1.2. The TSI only specifies interfaces that are necessary to achieve interoperability; for interfaces between track-side and on-board the TSI requires that their implementation (functions, protocols, electrical and physical aspects) complies with the mandatory specifications.

3.5.1.3. For other interfaces (e.g., between equipment allocated either on-board or track-side) different solutions are acceptable, provided that functional and performance requirements relevant for the achievement of interoperability are respected. These mandatory requirements are part of the basic parameters of the TSI.

3.5.1.4. To support an open market and the management of interoperability constituents during the whole lifetime (including maintenance and upgrade), voluntary harmonisation of aspects not mandated by the TSI is encouraged; the corresponding standards are listed in chapter 4 of this application guide.

3.5.2. Special considerations

3.5.2.1. The functions implemented in a RBC depend on its integration with track-side signalling, which is not harmonised in the scope of the TSI Control-Command and Signalling (see the consideration in chapter 3.2.2 above).

3.5.2.2. The specifications referenced in and given mandatory status by the TSI only define requirements for the functions implemented in the RBC, in order to achieve interoperability.

3.5.2.3. The necessity of implementing functions (e.g., if and in which conditions to authorise shunting, to send commands to raise / lower pantographs, etc.) depends upon the characteristics of the specific application.

3.5.2.4. As a consequence, different “types” of RBC interoperability constituent will be developed, to interface and cooperate with different track-side signalling functions.

3.5.2.5. The design documentation for the RBC will indicate which functions are implemented.

3.5.2.6. The advantage of defining the RBC as an Interoperability Constituent is twofold:

1. functions, interfaces and performance certified will not require repetitions of testing when the RBC is integrated into a Control-Command and Signalling track-side subsystem

2. the availability on the market of already certified RBCs will support the harmonisation of the overall track-side design, to exploit existing products and reduce the need to search for new technical solutions.

3.6. ASSESSMENT OF CONFORMITY OF THE CONSTITUENTS AND VERIFICATION OF THE SUBSYSTEM

3.6.1. Conformity assessment of ERTMS equipment

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3.6.1.1. The TSI Control-Command and Signalling lists the verifications performed, based on the general principles defined in chapter 3.2.3 above.

3.6.1.2. Additionally, the TSI requires that the Member States ensure that operational test scenarios for the ERTMS/ETCS and GSM-R track-side implementations are made available to the European Commission.

3.6.1.3. This will allow the achievement of two goals:

1. The possibility of early evaluation of the solutions adopted track-side (e.g., RBC functions and performance), to identify possible interoperability problems by means of tests against certified on-board equipment;

2. The possibility of testing in a laboratory an ETCS on-board equipment against different certified track-side implementations.

3.6.2. Use of harmonised standards

3.6.2.1. This section of the Application Guide refers to the EN 50126, EN 50128, EN 50129 and EN 50159 standards, listed in Annex A, table A3 of the Control-Command and Signalling TSI (and also as harmonised standards in [7]).

3.6.2.2. The concepts of these standards are used:

1. in SUBSET-091 (mandatory specification for the TSI Control-Command and Signalling [1], see Index 27 of Annex A, table A 2) to clarify the relationship between quantitative Tolerable Hazard Rates (THRs) and the requirements for the management of systematic failures during the development of a product;

2. in chapter 6 of the TSI Control-Command and Signalling [1], for the requirements related to the assessment of “RAMS”.

3.6.2.3. Some provisions within the standards are based on the assumption of the organisation of the railways before the entry in force of the different “railway packages” of European Directives, in particular the opening of the market and the separation of train operation from infrastructure management. A statement in Annex A of the Control-Command and Signalling TSI, before table A3, ensures that, where conflicts or possibility of different interpretation exist, the Directives and TSIs take precedence.

3.6.3. Partial conformity

3.6.3.1. Art. 18(5) of [3] states that “*If the relevant TSIs allow, the notified body may issue certificates of conformity for a series of subsystems or certain parts of those subsystems*”.

3.6.3.2. The TSI Control-command and Signalling in section 6.3.2 supports the issuing of certificates for a series of subsystems through the application of the modules.

3.6.3.3. The parts of On-board and, respectively, Track-side Control-command and Signalling subsystems for which a certificate may be issues are specified in section 2.2 and section 4.1 of the TSI. The corresponding rules for implementations are in section 7.2.1 and the rules for assessment are in section 6.4.2.

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3.6.3.4. In addition, in section 6.4.3 of the TSI provisions are given to manage partial conformity, when full compliance of an interoperability constituent with all relevant requirements is not assessed.

3.6.3.5. The scope of these provisions is not to open the door to new non-TSI compliant implementations, but to keep under control the situation that occurred in the initial phase of deployment of ERTMS/ETCS and GSM-R. A role is foreseen for the ad hoc group of Notified Bodies chaired by the Agency. The complete scope of work of this group is specified in [9].

3.7. IMPLEMENTATION OF THE TSI CONTROL-COMMAND AND SIGNALLING

3.7.1. Management of ERTMS specifications

3.7.1.1. Functional enhancement and error correction of the ERTMS/ETCS and GSM-R specifications is managed by the Agency, as system authority, applying its procedures for management of documents and the procedures for ERTMS Change Control Management [8].

3.7.1.2. The application of the principles for system version management ensures that the evolution of the ERTMS/ETCS and GSM-R specifications respects the conditions and limitations of backward compatibility.

3.7.2. Legacy Systems

3.7.2.1. The TSI specifies provisions for the management of the legacy systems (defined “Class B” in the TSI Control-Command and Signalling) during the transition phase under the responsibility of the relevant Member State. This includes the obligation to ensure that their functionality remains unchanged (with the only exception of modifications necessary to mitigate safety related flaws).

3.7.2.2. Section 7.2.7 of the TSI Control-Command and Signalling [1] refers to the rules for implementation of GSM-R (on-board and track-side), section 7.2.8 to the rules for train detection systems (only track-side, rules for vehicles are stated in the corresponding TSIs).

3.7.2.3. Rules for ETCS are stated in chapter 7.3 of the TSI Control-Command and Signalling [1]. It must be taken into account that, where installation of ETCS is not mandatory, a Member State may only require on-board installation of Class B train protection systems listed in the Technical Document referenced in section 2.2 of the TSI Control-Command and Signalling (see art. 2 of [1]).

3.8. OPEN POINTS

3.8.1. The open points related to Control-Command and Signalling are listed in Annex G of the TSI [1].

3.8.2. According to art 17(3) of [3] the Member States notify national rules for the management of open points, until they are solved with an update of the TSI.

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3.8.3. However, a Control-Command and Signalling Track-side or On-board subsystem where a National Rule is applied:

1. usually does not allow interoperability, and

2. might also be incompatible with future Control-Command and Signalling subsystems where the harmonised solution for the open point is applied

3.8.4. It is therefore advisable to limit as much as possible the negative effects of applying national rules in the implementation of Control-Command and Signalling subsystems. For this reason the Members States are invited, before deciding the rules to be notified, to check the “Notes” in Annex G and, if necessary, contact the Agency, to gather information about the scope of the open point and the state of the work for its solution.

3.8.5. Moreover, article 8 of [2] requires Member States to submit draft safety rules to the European Commission for examination; the European Commission will monitor strictly the introduction of any new rule in order to prevent further barriers from being created.

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4. SUPPORTING SPECIFICATIONS AND STANDARDS

4.1. FOREWORD

4.1.1. The requirement for compliance with TSI Control-Command and Signalling is supported by a set of specifications and standards, to promote an open market and to facilitate the management of equipment during the whole lifetime (including maintenance and upgrade).

4.2. USE OF THE SPECIFICATIONS AND STANDARDS

4.2.1. The specifications and standards in the tables of this chapter have been listed by the European Railway Agency, after a check of their scope and content with the cooperation of experts from the working parties (reference to Agency regulation) and with the opinion of Notified Bodies and National Safety Authorities. See [8].

4.2.2. The application of the specifications and standards listed in this Application Guide remains voluntary, as they refer to aspects of the Subsystems where the adoption of solutions that are not harmonised does not prejudice interoperability (provided the solution respects functional and performance requirements specified in the relevant basic parameters).

4.2.3. These specifications and standards shall not be confused with the specifications listed in the Annex A of the TSI Control-Command and Signalling [1], which are essential part of the definition of the basic parameters and are therefore mandatory.

4.3. REFERENCES

4.3.1. Table 3 indicates for each basic parameter (chapter 4 of the TSI Control-Command and Signalling [1]) the corresponding harmonised standards and/or informative specifications, which can support the development of interoperability constituents and subsystems and their certification.

Table 3: References

Reference in chapter 4 of TSI Control-Command and Signalling	No (see table 4 or 5)
4.1	
4.1a	45
4.1b	
4.1c	
4.2.1	
4.2.1 a	19, 20, 21, 22, 23, 24, 43, 44, 47
4.2.1 b	1
4.2.2	
4.2.2.a	
4.2.2.b	9, 10, 11, 12, 13, 14, 15, 16, 17, 39, 40, 41, 42, 50, 51
4.2.2.c	
4.2.2.d	
4.2.2.e	
4.2.3	

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Reference in chapter 4 of TSI Control-Command and Signalling	No (see table 4 or 5)
4.2.3 a	
4.2.3 b	9, 10, 11, 12, 13, 14, 15, 16, 17, 39, 40, 41, 42, 50, 52
4.2.3 c	
4.2.4	
4.2.4 a	
4.2.4 b	
4.2.4 c	
4.2.4 d	
4.2.4 e	5, 36, 37
4.2.4 f	
4.2.4 g	
4.2.4 h	
4.2.4 j	
4.2.5	
4.2.5 a	
4.2.5 b	
4.2.5c	
4.2.5 d	
4.2.5 e	
4.2.6	
4.2.6 a	3, 7, 8
4.2.6 b	
4.2.6 c	
4.2.6 d	
4.2.6 e	
4.2.6 f	4
4.2.7	
4.2.7 a	
4.2.7 b	
4.2.7 c	
4.2.7 d	
4.2.7 e	
4.2.8	
4.2.8 a	
4.2.9	
4.2.9 a	
4.2.9 b	
4.2.10	
4.2.10 a	
4.2.11	
4.2.11 a	H3, 48, 49
4.2.12	
4.2.12 a	25, 27, 28, 29, 30, 34

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Reference in chapter 4 of TSI Control-Command and Signalling	No (see table 4 or 5)
4.2.13	
4.2.13 a	25, 27, 28, 29, 30, 34
4.2.14	
4.2.14 a	
4.2.15	
4.2.15 a	
4.2.16	H1, H2, 2

4.4. HARMONISED STANDARDS

4.4.1. The following standards are referenced in [7].

Table 4: Harmonised standards

No	Reference	Document Name	Version	Notes
H1	EN 50125-1	Railway applications — Environmental conditions for equipment — Part 1: equipment on board rolling stock	1999	
H2	EN 50125-3	Railway applications — Environmental conditions for equipment — Part 3: equipment for signalling and telecommunications	2003	
H3	EN 50238	Railway applications — Compatibility between rolling stock and train detection systems	2003	

4.5. INFORMATIVE SPECIFICATIONS

4.5.1. In the “Notes” column of the following table some of the informative specifications are related to a mandatory specification, identified through the Index in the table of Annex A of the TSI Control-Command and Signalling [1].

4.5.2. In Notes, “1” means that the informative specification represents the state of the work for the preparation of the corresponding mandatory specification (that is “reserved” in Annex A of the TSI), while “2” means that the informative specification gives additional information to justify the mandatory requirements in the TSI or in a mandatory specification or to help for their application.

Table 5: List of supporting informative specifications

No.	Set of specifications #1 (ETCS baseline 2 and GSM-R baseline 0)				Set of specifications #2 (ETCS baseline 3 and GSM-R baseline 0)			
	Reference	**Document Name**	**Version**	**Notes**	**Reference**	**Document name**	**Version**	**Notes**
1	EEIG 02S126	RAM requirements (chapter 2 only)	6	2 (Index 28)	EEIG 02S126	RAM requirements (chapter 2 only)	6	2 (Index 28)
2	EEIG 97S066	Environmental conditions	5	2	EEIG 97S066	Environmental conditions	5	2
3	UNISIG SUBSET-074-1	Methodology for testing FFFIS STM	1.0.0	2 (Index 36)	UNISIG SUBSET-074-1	Methodology for testing FFFIS STM	reserved	2 (Index 36)
4	EEIG 97E267	Odometer FFFIS	5	1 (Index 44)	EEIG 97E267	Odometer FFFIS	5	1 (Index 44)

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No.	Set of specifications #1 (ETCS baseline 2 and GSM-R baseline 0)				Set of specifications #2 (ETCS baseline 3 and GSM-R baseline 0)			
	Reference	Document Name	Version	Notes	Reference	Document name	Version	Notes
5	O_2475	ERTMS GSM-R QoS test specification	3.0	2 (Index 33)	O_2475	ERTMS GSM-R QoS test specification	3.0	2 (Index 33)
6	Intentionally deleted				Intentionally deleted			
7	UNISIG SUBSET-074-3	FFFIS STM Test specification traceability of test cases with specific transmission module FFFIS	1.0.0	2 (Index 36)	UNISIG SUBSET-074-3	FFFIS STM Test specification traceability of test cases with specific transmission module FFFIS	reserved	2 (Index 36)
8	UNISIG SUBSET-074-4	FFFIS STM Test specification traceability of testing the packets specified in the FFFIS STM application layer	1.0.0	2 (Index 36)	UNISIG SUBSET-074-4	FFFIS STM Test specification traceability of testing the packets specified in the FFFIS STM application layer	reserved	2 (Index 36)
9	SUBSET 076-0	ERTMS/ETCS Class 1, test plan	2.3.3	2 (Index 37)	SUBSET 076-0	ERTMS/ETCS test plan and methodology	reserved	2 (Index 37)
10	SUBSET 076-2	Methodology to prepare features	2.3.0	2 (Index 37)	Intentionally deleted			
11	SUBSET 076-3	Methodology of testing	2.3.1	2 (Index 37	Intentionally delted			
12	SUBSET 076-4-1	Test sequence generation: methodology and rules	1.0.2	2 (Index 37)	Intentionally deleted			
13	SUBSET 076-4-2	ERTMS ETCS Class 1 states for test sequences	1.0.2	2 (Index 37)	Intentionally deleted			
14	SUBSET 076-5-3	Onboard data dictionary	2.3.0	2 (Index 37)	Intentionally deleted			
15	SUBSET 076-5-4	SRS v.2.3.0 traceability	2.3.3	2 (Index 37)	Intentionally deleted			
16	SUBSET 076-6-1	UNISIG test database	2.3.3	2 (Index 37)	SUBSET 076-6-1	test database	reserved	2 (Index 37)
17	SUBSET 076-6-4	Test cases coverage	2.3.3	2 (Index 37)	Intentionally deleted			
18	Intentionally deleted				Intentionally deleted			
19	UNISIG SUBSET 077	UNISIG causal analysis process	2.2.2	2 (Index 27)	UNISIG SUBSET 077	UNISIG causal analysis process	2.3.2	2 (Index 27)
20	UNISIG SUBSET 078	RBC interface: failure modes and effects analysis	2.4.0	2 (Index 27)	UNISIG SUBSET 078	RBC interface: failure modes and effects analysis	reserved	2 (Index 27)
21	UNISIG SUBSET 079	MMI: failure modes and effects analysis	2.2.2	2 (Index 27)	UNISIG SUBSET 079	MMI: failure modes and effects analysis	3.9.0	2 (Index 27)
22	UNISIG SUBSET 080	TIU: failure modes and effects analysis	2.2.2	2 (Index 27)	UNISIG SUBSET 080	TIU: failure modes and effects analysis	reserved	2 (Index 27)

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No.	Set of specifications #1 (ETCS baseline 2 and GSM-R baseline 0)				Set of specifications #2 (ETCS baseline 3 and GSM-R baseline 0)			
	Reference	Document Name	Version	Notes	Reference	Document name	Version	Notes
23	UNISIG SUBSET 081	Transmission system: failure modes and effects analysis	2.3.0	2 (Index 27)	UNISIG SUBSET 081	Transmission system: failure modes and effects analysis	3.3.0	2 (Index 27)
24	UNISIG SUBSET 088	ETCS Application levels 1 and 2 — safety analysis	2.3.0	2 (Index 27)	UNISIG SUBSET 088	ETCS Application levels 1 and 2 — safety analysis	3.5.0	2 (Index 27)
25	TS50459-1	Railway applications — Communication, signalling and processing systems — European Rail Traffic Management System — driver machine interface Part 1 — Ergonomic principles of ERTMS/ETCS/GSM-R information	2005	2 (Index 51)	TS50459-1	Railway applications — Communication, signalling and processing systems — European Rail Traffic Management System — driver machine interface Part 1 — Ergonomic principles of ERTMS/ETCS/GSM-R information	2005	2 (only for Index 33)
26	Intentionally deleted				Intentionally deleted			
27	TS50459-3	Railway applications — Communication, signalling and processing systems — European Rail Traffic Management System — driver machine interface Part 3 — Ergonomic arrangements of ERTMS/GSM-R information	2005	2 (Index 51)	TS50459-3	Railway applications — Communication, signalling and processing systems — European Rail Traffic Management System — driver machine interface Part 3 — Ergonomic arrangements of ERTMS/GSM-R information	2005	2 (only for Index 33)
28	TS50459-4	Railway applications — Communication, signalling and processing systems — European Rail Traffic Management System — driver machine interface Part 4 — Data entry for the ERTMS/ETCS/GSM-R systems	2005	2 (Index 51)	TS50459-4	Railway applications — Communication, signalling and processing systems — European Rail Traffic Management System — driver machine interface Part 4 — Data entry for the ERTMS/ETCS/GSM-R systems	2005	2 (only for Index 33)

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No.	Set of specifications #1 (ETCS baseline 2 and GSM-R baseline 0)				Set of specifications #2 (ETCS baseline 3 and GSM-R baseline 0)			
	Reference	**Document Name**	**Version**	**Notes**	**Reference**	**Document name**	**Version**	**Notes**
29	TS50459-5	Railway applications — Communication, signalling and processing systems — European Rail Traffic Management System — driver machine interface Part 5 — Symbols	2005	2 (Index 51)	TS50459-5	Railway applications — Communication, signalling and processing systems — European Rail Traffic Management System — driver machine interface Part 5 — Symbols	2005	2 (only for Index 33)
30	TS50459-6	Railway applications — Communication, signalling and processing systems — European Rail Traffic Management System — driver machine interface Part 6 — Audible information	2005	2 (Index 51)	TS50459-6	Railway applications — Communication, signalling and processing systems — European Rail Traffic Management System — driver machine interface Part 6 — Audible information	2005	2 (only for Index 33)
31	Intentionally deleted				Intentionally deleted			
32	Intentionally deleted				Intentionally deleted			
33	Intentionally deleted				Intentionally deleted			
34	ERA/ERTMS/015 5560	ERTMS/ETCS Driver Machine Interface	2.3	1 (Index 51)	Intentionally deleted			
35	Intentionally deleted				Intentionally deleted			
36	Intentionally deleted				Intentionally deleted			
37	UNISIG SUBSET-093	GSM-R Interfaces — Class 1 requirements	2.3.0	1 (Index 33)	UNISIG SUBSET-093	GSM-R Interfaces — Class 1 requirements	2.3.0	1 (Index 33)
38	Intentionally deleted				Intentionally deleted			
39	SUBSET-076-5-1	ERTMS ETCS Class 1 feature list	2.3.3	2 (Index 37)	Intentionally deleted			
40	ERA/ERTMS/040 063	Test sequences evaluation and validation	1.2.0	2 (Index 37)	Intentionally deleted			
41	SUBSET-076-6-8	Generic train data for test sequences	1.0.1	2 (Index 37)	Intentionally deleted			
42	SUBSET-076-6-10	Test sequence viewer (TSV)	3.2.2	2 (Index 37)	SUBSET-076-6-10	Test sequence viewer (TSV)	reserved	2 (Index 37)

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No.	Set of specifications #1 (ETCS baseline 2 and GSM-R baseline 0)				Set of specifications #2 (ETCS baseline 3 and GSM-R baseline 0)			
	Reference	Document Name	Version	Notes	Reference	Document name	Version	Notes
43	04E083	Safety requirements and requirements to safety analysis for interoperability for the control-command and signalling subsystem	1.0	2 (Index 27)	04E083	Safety requirements and requirements to safety analysis for interoperability for the control-command and signalling subsystem	1.0	2 (Index 27)
44	04E084	Justification report for the safety requirements and requirements to safety analysis for interoperability for the control-command and signalling subsystem	1.0	2 (Index 27)	04E084	Justification report for the safety requirements and requirements to safety analysis for interoperability for the control-command and signalling subsystem	1.0	2 (Index 27)
45	ERA/ERTMS/003205	Traceability of changes to ETCS FRS	1.0	2 (Index 1)	Intentionally deleted			
46	Intentionally deleted				Intentionally deleted			
47	UNISIG SUBSET-113	Report from UNISIG Hazard Log	reserved	2 (Index 27)	UNISIG SUBSET-113	Report from UNISIG Hazard Log	reserved	2 (Index 27)
48	TS 50238-2	Railway applications – Compatibility between rolling stock and train detection systems – Part 2: Compatibility with track circuits	2010	2 (index 77)	TS 50238-2	Railway applications – Compatibility between rolling stock and train detection systems – Part 2: Compatibility with track circuits	2010	2 (index 77)
49	TS 50238-3	Railway applications – Compatibility between rolling stock and train detection systems – Part 3: Compatibility with axle counters	2010	2 (Index 77)	TS 50238-3	Railway applications – Compatibility between rolling stock and train detection systems – Part 3: Compatibility with axle counters	2010	2 (Index 77)
50	ERA/ERTMS/040054	ETCS Engineering guidelines	1.0.0	2 (Index 4)			reserved	2 (Index 4)
51	Intentionally deleted				ERA/ERTMS/040055	ETCS DMI objects - START / STOP conditions	1.0.0	2 (Index 4 and Index 6)
52	ERA/ERTMS/040022	Baseline 2 requirements for implementation of braking curves functionality	2.0	2 (Index 4)	Intentionally deleted			

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ANNEX 1: BASIC PARAMETER 4.2.10 - SHUNTING IMPEDANCE FOR TRACK CIRCUITS

A track circuit is a section of the railway line, separated by the adjacent sections by means of insulated joints or “impedance bonds”; a signal is fed at one side of it and, in normal conditions, reaches the receiver at the opposite side.

If an axle of a vehicle “shunts” the rails, the level of the signals at the receiver is lowered below a threshold, indicating that the section is occupied.

To design a track circuit it is therefore necessary to determine the “shunting impedance”, i.e., the maximum impedance between the rails causing the signal at the receiver become lower than the threshold value.

Such “shunting impedance” is given by the impedance between the surface of the wheels of a vehicle and the “contact impedance” between the surfaces of the wheels and the surfaces of the rails.

Many factors contribute to the contact impedance (non exhaustive list):

1. Axle load (i.e., the force pressing the wheel surface against the rail surface)
2. Traction current (a current flowing at the contact surface may decrease the impedance between the wheel and the rail)
3. Dimension of the contact surface between wheels and rails
4. Rust on the surface of the wheels
5. Rust on the surface of the rails
6. Pollution on the surface of the wheels
7. Pollution on the surface of the rails

The factors 3, 4 and 5 are influenced by the dynamics of train movement, i.e., the relative displacement of wheels and rails during the movement, the speed and the train weight.

As far as factor 6 and 7 are concerned, while some sources of pollution are typical for trackside (e.g., leaves on rails), other sources may deposit an isolating film both on wheels and rails:

1. Brake blocks (composite types)
2. Sanding
3. Flange lubrication (on-board devices)
4. Flange lubrication (trackside devices)

The different contributions are represented in Figure A1-1.

Today many different types of track circuits are in service, operating at different frequencies and with different sensitivity for shunting impedance.

Some factors can be determined accurately and maintained during the vehicle life, like the values of impedance between the surfaces of wheels (clean) and of the axle load: they are therefore harmonised as interface parameters between rolling stock and trackside Control-Command and Signalling equipment in the TSI.

Similarly, being powered with electric traction is a permanent feature of a vehicle.

Other factors are more complex to manage:

1. Some depends on the interaction between a vehicle and a specific infrastructure, like the dimension of the contact surface.

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2. Some are vehicle characteristics (affecting all infrastructures where the vehicle runs), and can be kept under control with operational rules related to vehicle movements (like rust on wheels).
3. Some are trackside characteristics, only affecting one infrastructure, and can be kept under control with operational rules related to vehicle movements (like rust on rails).
4. Some are originated trackside and affect both vehicles and infrastructures, creating isolating layers on wheels and rail surfaces (like trackside flange lubrication).
5. Some are originated on-board and affect both vehicles and infrastructures, creating isolating layers on wheels and rail surfaces (like on-board flange lubrication, brake blocks and sanding).

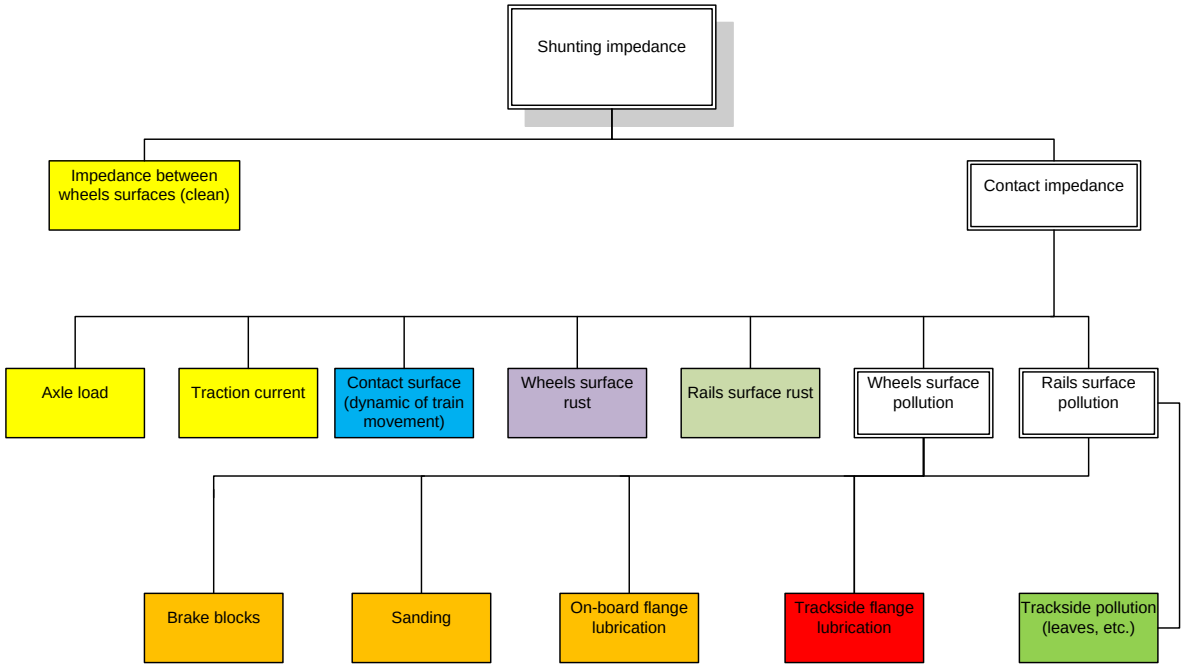

Figure A1-1: contributions to the “shunting impedance” (non exhaustive list)

Only technical requirements on the interface between wheels and rails are specified in the TSI and it is indicated where operational rules can be necessary.

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ANNEX 2: BASIC PARAMETER 4.2.11 - ELECTROMAGNETIC FIELDS

General principles

The proposed frequency management principle is based upon the integration of known Axle Counter immunity levels, coupled with rolling stock emissions, for compatibility purposes, to enable current and future interoperability.

The frequency management of intra system (between Axle Counters) and inter system (between Axle Counters and rolling stock) compatibility requirements is based upon the list of known Axle Counters currently in use. The rolling stock emission limits and the evaluation parameters have been determined from the known in-band susceptibility threshold limits for Axle Counters, which includes a 9 dB margin pertinent to the correct bandwidths of operation of the respective Axle Counter, established from laboratory tests.

The frequency management proposes three distinct frequency bands. These ranges have been established from known technologies and encompass the differences in manufacture, to allow for flexibility and compatibility between Axle Counters when mounted close to each other on the infrastructure.

Rolling stock emission requirements

The general coupling mechanisms and principal electromagnetic phenomena for emissions and immunity are adequately described in EN50121-1 Annexe A. For the purposes of the proposed frequency management in respect of the compatibility between rolling stock and axle counters, particular attention is drawn to the pulsed switching circuits in operation on modern railway vehicles. These can produce higher levels of harmonics and transients in return currents than previously seen on railway vehicles containing less complex technologies. Nevertheless, they can be considered as the main source of interference to Axle Counters. Critical to this are the short rise-time pulses with high repetition rates.

Pulsed oscillating magnetic fields at or near the Axle Counter sensor position are generated by common-mode currents underneath the railway vehicles, flowing in uncontrolled paths. As a consequence, the qualification of rolling stock emitted magnetic field levels is highly dependant upon the filter bandwidth used for the qualification for evaluation.

In-band emission limits for the three frequency bands and the corresponding evaluation parameters including frequency range, bandwidth and integration time have been optimised for due consideration of both rolling stock and Axle Counters. Out of band emission limits are defined as a result of practical experience with max emissions envelope of magnetic field levels for existing rolling stock and considerations for compatibility with the EMC Directive.

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