

# Selected Aspects of Control-Command and Signalling On-Board Subsystem Verification

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## Summary

This article describes the procedures, standard parameters and control requirements to be performed in order to achieve EC verification of a Control-Command and Signalling On-board Subsystem. An analysis of issues related to the assessment of the on-board subsystem is presented in terms of the necessary checks that must be performed by a notified body and the issues of interoperability tests of the on-board ERTMS with track-side infrastructure.

Providing railway interoperability is strictly related to the introduction of unified rules for the assessment and verification of the ETCS and GSM-R subsystems that are part of the European Rail Traffic Management System (ERTMS). The article describes procedures, standard parameters, requirements and necessary controls that must be implemented to carry out EC Verification of a Control-Command and Signalling On-board Subsystem. Reference is also made to the issues of ERTMS on-board compatibility tests with track-side infrastructure.

**Keywords:** TSI, CCO, ERTMS, conformity assessment, interoperability

## 1. Introduction

Providing railway interoperability is strictly related to the introduction of unified rules for the assessment and verification of the ETCS and GSM-R subsystems that are part of the European Rail Traffic Management System (ERTMS). According to Directive 2008/57/EC [4], Control-Command and Signalling Subsystems are “all the equipment necessary to ensure safety and to control train traffic on the network.” These subsystems can also be characterized by the functions necessary for safe rail traffic control and necessary for its operation, interfaces and the level of operational parameters required to meet the essential requirements (safety, reliability and availability, health, environmental protection and technical compatibility) [7]. In addition, it should be noted that the control-command and signalling subsystems are divided into “Control-Command and Signalling On-board Subsystem” and “Control-Command and Signalling Trackside Subsystem”. This division is necessary because of the transparency of the functional and technical specifications that these subsystems and their interfaces must meet.

## 2. Control-Command and Signalling On-board Subsystem Verification Modules

The subsystems mentioned in the introduction are subject to conformity verification with European requirements, as defined in the Directive on the interoperability of the rail system within the EU, the relevant TSIs and other provisions deriving from the Treaty. These procedures are implemented by notified bodies, which issue the relevant EC certificates of verification when the conformity of the subsystems is successfully completed. It should be specified that the conformity verification of the subsystem does not have to cover the entire subsystem, but may be implemented for a part of the subsystem or for a specific assessment stage, for example, overall design, installation or final testing.

The manufacturer of a Control-Command and Signalling On-board Subsystem or a contracting entity is allowed to choose the following modes of conformity verification:

- the type-examination procedure (Module SB) for the design and development phase in combination with

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- the production quality management system procedure (Module SD) for the production phase; or
- the type-examination procedure (Module SB) for the design and development phase in combination with the product verification procedure (Module SF); or
  - the full quality management system with design examination procedure (Module SH1).

Each of the above mentioned modules is described in detail in the Commission Decision 2010/713/UE [2]. According to the Control-Command and Signalling TSI provisions, a design review is required for the SB module and a type-test is required for the SH1 module.

### 3. Verification of the control-command subsystem installed on a vehicle

As previously presented, for the purpose of verification, the applicant may choose 1 out of 3 modules for assessment procedures. Regardless of the module chosen, the verification must demonstrate that the Control-Command and Signalling On-board Subsystem after integration with the vehicle meets the basic parameters. At the same time, it is recognized that no additional verification of the functions and performance parameters is required for the interoperability constituents of the subsystem, which have been covered by the EC declaration of conformity. The following section describes the basic parameters and the specific requirements for assessing an on-board subsystem.

#### 3.1. Control-Command and Signalling On-board Subsystem Standard Parameters

All subsystems constituting the rail system within the EU must meet the essential requirements, the specific aspects and detailed requirements of which are described in the relevant TSI. Chapter Four of the Control-Command and Signalling TSI (2016/919) [3] defines the basic parameters for A-Class systems (ETCS and GSM R), both on track-side and on-board equipment, including a division into parts.

The following parameters have been adopted for on-board equipment:

- 1) Train protection:
  - Control-Command and Signalling safety characteristics relevant to interoperability;
  - On-board ETCS functionality;
  - ETCS and GSM-R air gap interfaces;
- On-Board Interfaces Internal to Control-Command and Signalling;
- Key management;
- ETCS-ID Management;
- ETCS DMI (Driver-Machine Interface);
- Interface to Data Recording for Regulatory Purposes;
- Construction of equipment used in CCS subsystems

  - 2) Voice radio communication:
    - Availability / Reliability;
    - Basic communication function;
    - Voice and operational communication applications;
    - Radio communications with the train;
    - GSM-R (Driver-Machine Interface);
    - Construction of equipment used in CCS subsystems.
  - 3) Data Radio Communication:
    - Availability / Reliability;
    - Basic communication function;
    - Data communication applications for ETCS;
    - Radio communications with the train;
    - Interface between GSM-R Radio Data Communication and ETCS;
    - Construction of equipment used in CCS subsystems.

Each of the above-mentioned basic parameters is characterized and applies to specific requirements that must be met to ensure interoperability.

#### 3.2. Requirements for assessing the on-board subsystem

The notified body, as part of the subsystem verification, must perform the checks specified in Clause 6.3.3 of the Control and Command and Signalling TSI that address the following aspects:

- 1) Use of interoperability constituents;
- 2) Integration of interoperability constituents into the subsystem;
- 3) Integration with rolling stock;
- 4) Integration with Class B equipment;
- 5) Integration with Control-Command and Signalling Track-side Subsystems;
- 6) Reliability, Availability, Maintainability and Safety (RAMS);
- 7) Integration with Control-Command and Signalling Track-side Subsystems and other subsystems – testing under operational conditions.

<sup>2</sup> Standard data type library.

For the aspect from point 1) it should be checked whether all interoperability constituents intended to be included in the subsystem are covered by the EC declaration of conformity and the relevant certificate. Limitations on the use of these constituents should also be considered and, where these constituents are certified against previous versions of the Control-Command and Signalling TSI, compliance with the TSI currently in force should be checked.

The verification of issue 2) consists of checking: the correct installation and functioning of the internal interfaces of the subsystem according to the basic parameters (on-board interfaces inside the Control-Command and Signalling Subsystem), the impact of additional functions (if any) not specified in the TSI on the mandatory functions, and the values of the ETCS-ID parameters.

The assessment of the integration with rolling stock is based on tests for correct installation of the equipment to comply with the conditions specified in the basic parameters (on-board ETCS functions, GSM-R functions for mobile communication on railways, Interface to Data Recording for Regulatory Purposes) and the installation conditions specified by the manufacturer. It should also be checked that the Control-Command and Signalling On-board Subsystem is compatible with the rolling stock in which it is to be operated (compliance with a basic parameter – design of equipment used in Control-Command and Signalling subsystems) and that the parameters, e.g. braking, are correctly configured and within the permitted range.

The analysis in terms of integration with B-Class equipment is based on verifying: the compatibility of the external STM interface (if used) with the on-board ETCS, that B-Class functions implemented in ETCS on-board and separate B-Class equipment not interfaced with ETCS on-board do not create additional requirements for the Control-Command and Signalling Track-side Subsystem. If the subsystem uses a combination of separate B-Class equipment with ETCS on-board, using partially non-TSI conforming interfaces, it should also be checked that this equipment does not create additional requirements for the Control-Command and Signalling Track-side Subsystem and that ETCS equipment is operating smoothly.

For the assessment of point 5), the correctness of the installation of the on-board antenna for reading Eurobalise telegrams and (if applicable) the correctness of the reading of Euroloop telegrams and the handling of GSM-R calls in terms of voice and data (confirmation of compliance with the requirements for the standard parameter – ETCS and GSM-R interfaces) should be mainly checked.

Reliability, Availability, Maintainability and Safety (RAMS) aspects are to be assessed by checking com-

pliance with the requirements of points 4.2.1 and 4.5.2 of the CCS TSI.

An important task in the verification process of a Control-Command and Signalling On-board Subsystem is to perform tests under different operational conditions, which must demonstrate the correct performance of odometry functions, compatibility with the vehicle on which the subsystem is installed and the absence of systematic failings.

#### **4. Interoperability tests between on-board ERTMS and track-side infrastructure**

As mentioned earlier, the Control-Command and Signalling On-board and Track-side TSIs specify the need for cross-checking the conformity of Control-Command and Signalling On-board and Track-side subsystems. On this basis, vehicles equipped with ETCS and GSM-R on-board equipment should be tested for compatibility with ETCS and GSM-R track-side installations during the approval process [1].

Vehicle tests are performed on the basis of the so-called operational scenarios on selected sections of a railway network [6]. The implementation of these checks is therefore highly dependent on the rules and internal procedures of the infrastructure manager, which have to be fulfilled before tests are launched. The procedure starts with the specification of a given test section that meets the relevant criteria. A technical and operational risk assessment should then be implemented for the vehicle tested over the section concerned, taking into account all the parameters affecting the tests. Further, in agreement with all parties involved in the testing of specific rolling stock, a provisional running rule should be established on the basis of which specific track closures are to be introduced.

The above steps allow tests to be started to verify the correct integration of the Control-Command and Signalling On-board and Track-side Subsystem. Checks are based on generating a sequence of events leading to the expected results. The testing team members, in co-operation with the train driver, train dispatchers, fitters and dedicated technical staff, arrange individual traffic situations. The results of the checks performed are included in a dedicated test report.

#### **5. Conclusions**

The verification process for the Control-Command and Signalling On-board Subsystem is complex and requires numerous and time-consuming checks. In many aspects of this task, there are difficulties in interpreting

the provisions of European requirements. Therefore, appropriate guides and recommendations related to the EC assessment processes are published. In this respect, the qualifications of the staff of the notified conformity assessment bodies, which were set out in the Railway Interoperability Directive 2016/797 [5], are also very important. When analysing the requirements for the assessment of the on-board subsystem presented in this article, attention should be paid to the need to perform tests in operating conditions that will confirm proper integration with the Control-Command and Signalling Track-side Subsystem and other subsystems. These tests should include test cases from the so-called operational test scenarios that are made available to the European Railway Agency by individual Member States.

## Literature

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