ERTMS/ETCS

FUNCTIONAL REQUIREMENTS FOR AN ON-BOARD REFERENCE TEST FACILITY

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1. AMENDMENT RECORD

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3.0.0	06/05/14	1	Baseline 3 1st Maintenance release version	Oscar Rebollo

2. TABLE OF CONTENTS

3. REFERENCES, TERMS AND ABBREVIATIONS

3.1 Reference documents

Table 1 : Reference documents

Ref. N°	Document Reference	Title
[1]	Subset-023	Glossary of Terms and Abbreviations
[2]	Subset-026	System Requirements Specification
[3]	Subset-027	FIS Juridical Recording
[4]	Subset-034	TIU FIS
[5]	Subset-035	STM FFFIS
[6]	Subset-036	Eurobalise FFFIS
[7]	Subset-037	Euroradio FIS
[8]	Subset-044	FFFIS for Euroloop
[9]	A11 T6001	Radio transmission FFFIS for Euroradio
[10]	Subset-056	Safe Time Layer STM FFFIS
[11]	Subset-057	Safe Link Layer STM FFFIS
[12]	Subset-058	Application Layer STM FFFIS
[13]	Subset-085	Test specification for Eurobalise FFFIS
[14]	Subset-076-6-3	Test Sequences
[15]	Subset-076-3	Methodology of testing
[16]	ERA_ERTMS_040063	Test Sequence validation and evaluation for Ss-076
[17]	Subset-040	Dimensioning and engineering rules
[18]	Subset-041	Performance requirements for interoperability
[19]	ERA_ERTMS_015560	ETCS Driver Machine Interface
[20]	Subset-059	Performance requirements for STM
[21]	Subset-048	Trainborne FFFIS for Radio Infill
[22]	Subset-047	Trackside-Trainborne FIS for Radio Infill
[23]	Subset-038	Offline key management FIS
[24]	Subset-092-1	ERTMS Euroradio Conformance Requirements
[25]	Subset-092-2	ERTMS Euroradio Test Cases Safety Layer
[26]	Subset-076-6-8	Generic train data for Test Sequences

3.2 Terms and abbreviations

3.2.1.1 For general terms, definitions and abbreviations refer to document [1]. New terms and abbreviations used in this document are specified here.

Table 2 : Abbreviations

Abbreviation	Definition
AET	Automatic Evaluation Tool
BCS	Eurobalise Communication Simulator
BTS	Eurobalise Telegram Simulator
CCS	Control, Command and Signalling
CMD	Cold Movement Detection
CMD-A	Cold Movement Detection Adaptor
CMS	Cold Movement Simulator
DIS	DMI Interface Simulator
EB-A	Eurobalise Antenna
EL-A	Euroloop Antenna
ISDN	Integrated Services Digital Network
JRI	Juridical Recording Interface
JRI-A	Juridical Recording Interface Adaptor
JRS	Juridical Recording Simulator
LCS	Euroloop Communication Simulator
LER	Laboratory Event Recorder
LMS	Euroloop Messages Simulator
LSC	Laboratory Scenario Controller
LSE	Laboratory Scenario Editor
ODO	Odometry function
ODO-A	Odometry Adaptor
RCS	Euroradio Communication Simulator
RMS	Euroradio Messages Simulator
SCS	STM Communication Simulator
SIM-A	Simulation Management Adaptor
SMS	STM Messages Simulator
SSS	Speed Sensor Simulator
TDA	Train Data Acquisition through external sources
TDA-A	Train Data Acquisition Adaptor
TDS	Train Data Simulator
TIU-A	Train Interface Unit Adaptor
TIS	Train Interface Simulator
TMS	Train Motion Simulator
TSI	Technical Specification for Interoperability

4. OBJECTIVES

4.1.1.1 This document defines the functional requirements for an ETCS reference test facility to perform tests on the on-board Interoperability Constituent.

4.1.1.2 It is also defined the prior requirements to be fulfilled by an on-board Interoperability Constituent before testing.

4.1.1.3 The reference test facility provides an environment for the execution of the tests specified in Subset-076-6-3 (See [14]).

4.1.1.4 This document and Subset-076-6-3 (See [14]), are the means envisaged by the TSI CCS to check the Basic Parameter *On-board ERTMS/ETCS functionality*, present in both Interoperability Constituents *ERTMS/ETCS on-board* and *Odometry*. This means that these documents define only part of the tests to be done on the above mentioned Interoperability Constituents, in order to achieve an EC Declaration of Conformity.

4.1.1.5 It is strongly recommended to perform the tests included in Subset-076-6-3 (See [14]), once the Basic Parameters *CCS safety characteristics relevant for interoperability*, *ERTMS/ETCS and GSM-R airgap interfaces* (only Eurobalise and Euroloop airgap interface), *On-board interfaces internal to CCS*, *ERTMS/ETCS DMI* and *Interface to data recording for regulatory purposes* have been proved.

5. INTRODUCTION

5.1.1.1 The test architecture described in this document is focused on performing the tests defined in Subset-076-6-3 (See [14]), and hence, the compliance with Subset-026 (See [2]).

5.1.1.2 The test specifications in Subset-076-6-3 (See [14]) are designed to check the functional behaviour of the ERTMS/ETCS on-board equipment.

5.1.1.3 Note: within Subset-076-6-3 (See [14]) there are also some functional requirements with timing constraints. This kind of situations is also covered by the present document.

5.1.1.4 According to Subset-076-3 (See [15]), the object under test, i.e. the ERTMS/ETCS on-board equipment, is considered as a Black Box with a fixed number of defined interfaces and their determined range of values.

5.1.1.5 The interfaces are defined in Subset-026 (See [2]), section 2.5.3, “ERTMS/ETCS Reference Architecture” and are covered by European specifications.

5.1.1.6 The test facility shall therefore interact with the ERTMS/ETCS on-board equipment through these interfaces.

5.1.1.7 The test facility shall provide FFFIS compliant interfaces, where defined.

5.1.1.8 For the other cases, where only FIS specification is available, this document provides the needed complementary information to allow the data exchange between the ERTMS/ETCS on-board equipment and the test facility.

5.1.1.9 For a proper testing, the test facility shall also provide the appropriate inputs to the on-board internal functions odometry, cold movement detection and train data acquisition. Since these internal interfaces are not standardized, this document provides the needed information to allow the data exchange between the ERTMS/ETCS on-board equipment and the test facility.

5.1.1.10 For the ERTMS/ETCS on-board equipment, only the internal function odometry is considered mandatory, while the cold movement detection is considered as optional in Subset-026 (See [2]). Hence, although the test facility description provided in this document, contains all the possible interfaces, the optional ones shall only be used when implemented on the ERTMS/ETCS on-board equipment. The train data acquisition is a mandatory function but the way of implementation is not harmonised, a test adaptor is proposed to interface with the test bench for this function.

5.1.1.11 The analysis of the tests shall be done using the data extracted from the standard interfaces.

5.1.1.12 The components related to Euroloop and STM have been defined, although they are considered as optional interfaces for the ERTMS/ETCS on-board equipment. Finally, the test architecture should be reviewed in the future to cope with the Level 3 functionality.

6. REFERENCE ON-BOARD EQUIPMENT TEST ARCHITECTURE

6.1 Test basics

6.1.1 Scenario definition

6.1.1.1 The test basic unit shall be the scenario.

6.1.1.2 A scenario shall be composed by the following data:

a) Test sequence (Subset-076-6-3) information: trackside messages to be sent to the equipment under test, basic speed profile, timing and location of the simulation.

b) Track description (track conditions and gradient profiles).

c) Train description, comprising train parameters for the dynamic simulation and train data to be sent to the on-board equipment (see [26]).

d) Simulations details (e.g. list of modules to be used during the simulation and their configuration options).

6.1.1.3 Note: with such an structure, the functional tests, represented by scenarios, gains in flexibility. This architecture makes possible to use the same Test Sequence definition while adapting the test environment to the design choices of the ERTMS/ETCS on-board equipment.

6.1.1.4 This flexibility is necessary, in order to accomodate the reference test facility to the implementation freedom in the ERTMS/ETCS on-board equipment, as stated in Subset-026 (see [2]), paragraph 1.7.1.3.

6.1.1.5 Also due to testing circumstances (see [16]), it might be necessary to divide the scenario in several parts in order to guarantee a complete coverage.

6.1.2 Simulation phases

6.1.2.1 The process for performing a test shall go through several phases, summarized in the following requirements.

6.1.2.2 Preparation of the adequate internal states of the ERTMS/ETCS on-board equipment, according to the specific Scenario to be tested. This objective can be achieved by the simulation of a short pre-sequence or, optionally, by means of the Maintenance Module provided by the ERTMS/ETCS on-board equipment supplier.

6.1.2.3 Simulation start. Initialization and synchronization of the lab modules and the Test Adaptor: within this phase the lab modules shall prepare for the simulation and the different communication links with the Test Adaptor shall be established.

6.1.2.4 Initial communication with the Test Adaptor. Within this phase, the train data and the cold movement sensor information shall be provided to the adaptor, if necessary. The initial TIU inputs status shall also be transferred to the Test Adaptor.

6.1.2.5 Scenario run. The scenario starts with the power up of the ERTMS/ETCS on-board equipment under test (or opening the desk, depending on the Test Sequence) and finishes when the equipment under test is switched off.

6.1.2.6 Simulation stop. Within this phase, the lab modules and the Test Adaptor shall be stopped. The On-board Recording Device shall be downloaded, if available. Some optional maintenance functions (e.g. deletion of juridical data) can also be performed during this phase.

6.1.3 General overview

6.1.3.1 An overview of the ETCS On-board test architecture is shown in the next figure:

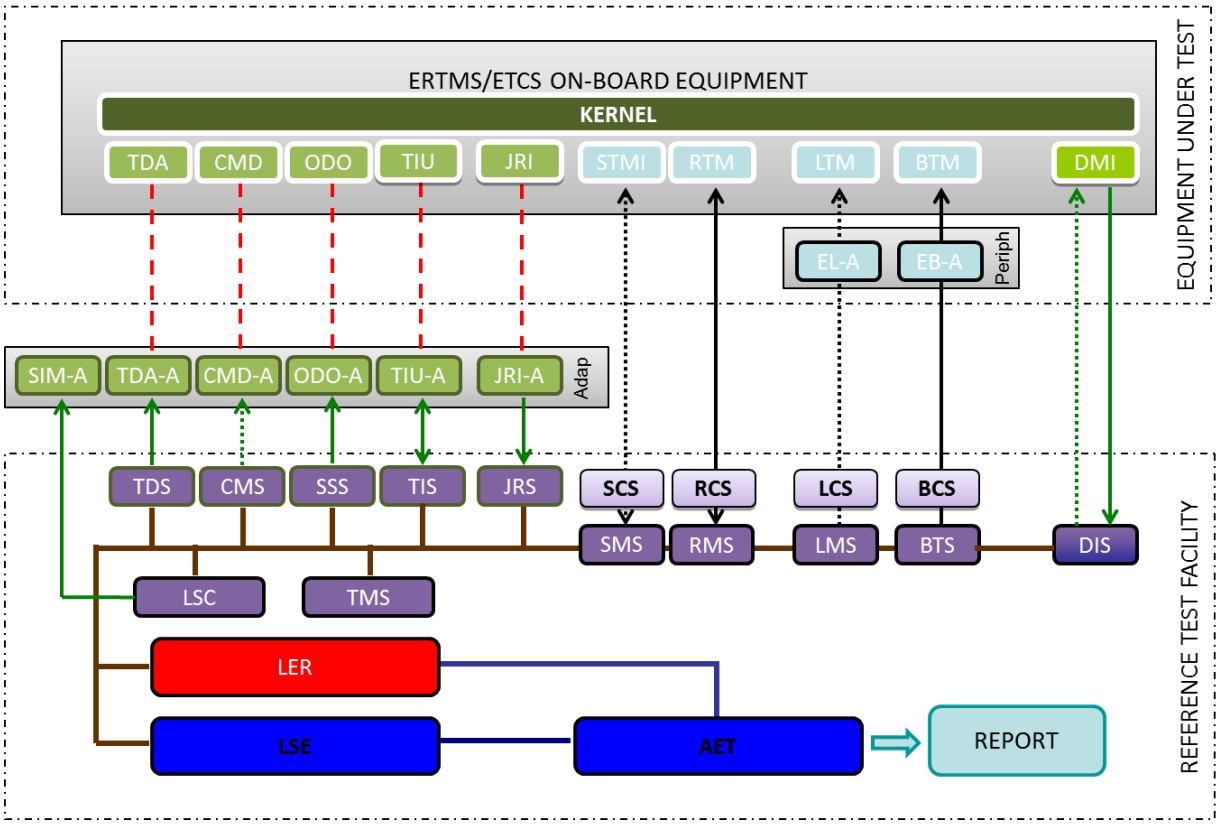


Figure 1: Reference test architecture for ERTMS/ETCS on-board equipment

6.1.3.2 In Table 3, additional information about the different elements in Figure 1 is provided.

Table 3: Drawing convention in Figure 1

Element	Feature	Description	Meaning	Comment
Link	Color	Green	Defined in Subset-094	On-board equipment-Reference Test Facility
Link	Color	Black	Defined in european specifications	On-board equipment-Reference Test Facility
Link	Color	Red	Internal	On-board equipment
Link	Line	Dotted	Optional interface	On-board equipment-Reference Test Facility
Link	Line	Continuous	Mandatory interface	On-board equipment-Reference Test Facility
Link	Line	Discontinuous	Internal	On-board equipment
Link	Color	Brown	Simulation link	Internal Reference Test Facility
Link	Color	Dark Blue	Analysis and evaluation link	Internal Reference Test Facility
Module	Color	Green	Functional module, whose interface, if described, is only at functional level	Internal On-board equipment
Module	Color	Light Blue	Functional module whose interface is described at FFFIS level	Internal On-board equipment

Element	Feature	Description	Meaning	Comment
Module	Color	Green	Functional module whose interface with the reference test facility is described at FFFIS level	Internal Test Adaptor
Module	Color	Purple	Functional module with an active role during the simulation	Internal Reference Test Facility
Module	Color	Light purple	Functional module with an active role during the simulation, whose interface is described at FFFIS level	Internal Reference Test Facility
Module	Color	Red	Functional module with a passive role during the simulation	Internal Reference Test Facility
Module	Color	Blue	Functional module not used during the simulation	Internal Reference Test Facility

6.1.3.3 In Table 2, the meaning of every acronym in Figure 1 is provided. The references to the appropriate specifications for every module are provided in Table 4.

Table 4: Figure 1 references.

Name	Reference	Side
RTM	[2], [7], [9], [21], [22], [24] and [25]	On-board equipment
BTM + EB-A	[2], [6] and [13]	On-board equipment
LTM + EL-A	[2] and [8]	On-board equipment
STMI	[2], [5], [10], [10], [12] and [20]	On-board equipment
JRI	[2] and [3]	On-board equipment
DMI	[2] and [19]	On-board equipment
TIU	[2] and [4]	On-board equipment
ODO	[2]	On-board equipment
CMD	[2]	On-board equipment
TDA	[2]	On-board equipment
TDA-A	Subset-094	TEST ADAPTOR
CMD-A	Subset-094	TEST ADAPTOR
ODO-A	Subset-094	TEST ADAPTOR
TIU-A	Subset-094	TEST ADAPTOR
JRI-A	Subset-094	TEST ADAPTOR
SIM-A	Subset-094	TEST ADAPTOR
RCS	[7], [9], [17], [21], [22], [23], [24], [25] and Subset-094	LAB
BCS	[6], [13], [17] and Subset-094	LAB
LCS	[9], [17] and Subset-094	LAB
SCS	[5], [10], [11], [12], [20] and Subset-094	LAB
DIS	[19] and Subset-094	LAB
TIS	[4] and Subset-094	LAB
SSS	Subset-094	LAB
CMS	Subset-094	LAB
TDS	Subset-094	LAB
JRS	[3] and Subset-094	LAB
RMS	Subset-094	LAB
BTS	Subset-094	LAB
LMS	Subset-094	LAB

Name	Reference	Side
SMS	Subset-094	LAB
TMS	Subset-094	LAB
LER	Subset-094	LAB
LSC	Subset-094	LAB
LSE	Subset-094	LAB
AET	Subset-094	LAB

6.1.3.4 The boxes shown in Figure 1, grouped within the *Equipment under test* frame, are just functional modules with the only exception of the peripherals (EL-A and EB-A). The internal implementation details depend exclusively on the ERTMS/ETCS on-board equipment supplier.

6.1.3.5 The boxes shown in Figure 1, grouped within the *Reference Test Facility* frame, are just functional modules. The internal implementation details are out of the scope of this document.

6.1.3.6 For every non-FFFIS interface in the ERTMS/ETCS on-board equipment, this document defines an equivalent FFFIS interface for testing purposes. In case of existing functional specification (ex., see [3] or [4]), this document shall simply add the form fit part. However, in order to avoid contradictions with the current specifications, these test interfaces are moved to the so-called Test Adaptor module.

6.2 Equipment under test

6.2.1 General issues

6.2.1.1 As described in figure 1, the equipment under test shall be composed by the ERTMS/ETCS on-board equipment.

6.2.1.2 With regards to the juridical information, the ERTMS/ETCS on-board unit supplier might decide to provide a complete On-board Recording Device.

6.2.1.2.1 In case an On-board Recording Device is provided, the downloading tool shall also be supplied. Moreover, the ERTMS/ETCS on-board unit supplier shall provide the detailed description about the electronic format used to store the juridical ETCS data in order to make this information available to the reference test architecture.

6.2.1.2.2 In case an On-board Recording Device is provided, the JRI-A and the JRS shall not be necessary.

6.2.2 ERTMS/ETCS on-board equipment

6.2.2.1 The ERTMS/ETCS on-board equipment is defined in Subset-026, section 2.5.2.2 (see [2]).

6.2.2.2 This definition is completed by the Technical Specification for Interoperability relating to the Control Command and Signalling Subsystem, where, in section 5, the basic interoperability constituents for the on-board assembly are defined (see table 5.1.a). The paragraph 5.2.2 covers the possibility to combine some basic interoperability constituents to form a larger unit. A proposal of such a group is given in table 5.1.b.

6.2.2.3 Due to the lack of specifications in certain topics and for testing convenience, the ERTMS/ETCS on-board equipment to be tested in the current reference test architecture shall comply with Group #1 of interoperability constituents as defined in table 5.1.b of the TSI CCS , with the following exceptions:

a) The basic Interoperability Constituent *Odometry* shall not be fully implemented, as the odometry sensors providing computable data to the ETCS internal odometry function shall not be included. In its place an ODO-A shall be used with the ERTMS/ETCS on-board equipment to complete the functionality provided by the Reference Test Facility.

b) The raw data for the *Odometry* shall be provided by the SSS.

c) The odometry related tasks distribution between the ODO-A and the ERTMS/ETCS on-board equipment is out of the scope of this document.

d) The internal function *Cold Movement Detection*, if available, shall not be fully implemented as the device providing this information shall not be included. In its place a CMS-A shall be used with the ERTMS/ETCS on-board equipment to complete the functionality provided by the Reference Test Facility.

e) The raw data for the *Cold Movement Detection* shall be provided by the CMS.

f) The cold movement related tasks distribution between the CMS-A and the ERTMS/ETCS on-board equipment is out of the scope of this document.

g) The internal function *Train Data Acquisition from external sources*, if available, shall not be fully implemented as the train data external source providing this information shall not be included. In its place a TDA-A shall be used with the ERTMS/ETCS on-board equipment to complete the functionality provided by the Reference Test Facility.

h) The raw data for the *Train Data Acquisition from external sources* shall be provided by the TDS.

i) The train data acquisition related tasks distribution between the TDA-A and the ERTMS/ETCS on-board equipment is out of the scope of this document.

j) The *Train Interface Unit* to the Subsystem Rolling Stock is only defined at functional level (see [4]). A TIU-A shall be used with the on-board equipment to complete the functionality provided by the Reference Test Facility.

k) The TIU-A shall exchange the *Train Interface Unit* information with the TIS.

l) The train interface related tasks distribution between the TIU-A and the ERTMS/ETCS on-board equipment is out of the scope of this document.

m) For the communication with the RBC and, optionally, Radio in-fill unit, the on-board internal GSM-R/ETCS interface shall be used, including the Euroradio protocols.

n) For the interface to the *On-board recording device*, included in the Rolling Stock Subsystem, only the functional description of the information is included in the TSI CCS. A JRI-A shall be used with the on-board equipment to complete the functionality provided by the Reference Test Facility.

o) The JRI-A shall send the Juridical Recording information to the JRS.

p) Alternatively to points n) and o), a complete *On-board recording device* might be supplied with the ERTMS/ETCS on-board equipment (see 6.2.1.4).

6.2.2.4 The remaining ETCS air gap interfaces for Eurobalises and, optionally, Euroloop shall be implemented as defined in the TSI, for the communication between the reference test architecture modules and the ERTMS/ETCS on-board equipment.

6.2.2.5 The STM interface, if available, shall be implemented as defined in the TSI for the communication with the reference test architecture modules.

6.2.2.6 The Key Management system interface, if available, shall be managed internally by the ERTMS/ETCS on-board equipment supplier and is not intended to be connected to the reference test architecture module.

6.2.2.7 The ETCS ID management interface, if available, shall be managed internally by the ERTMS/ETCS on-board equipment supplier and is not intended to be connected to the reference test architecture module.

6.2.2.8 The ETCS Driver Machine Interface shall be implemented as defined in reference [19] and managed by the corresponding reference test architecture module.

6.2.3 The maintenance module

6.2.3.1 The maintenance module is an external module to the ERTMS/ETCS on-board equipment which enables to perform some maintenance functions (e.g. download internal memory logs, set initial configuration, etc) through proprietary interfaces.

6.2.3.2 The use of this module is not mandatory, but recommended, in order to increase the testing efficiency.

6.2.3.3 This module shall not be connected to any reference test architecture module.

6.2.3.4 This module shall never be used for the validation of test results for the Subset-076 (see [14]).

6.3 The Test Adaptor

6.3.1 General issues

6.3.1.1 The Test Adaptor is a module (no matter the implementation details) provided by the ERTMS/ETCS on-board equipment supplier.

6.3.1.1.1 Note: if agreed by both ERTMS/ETCS on-board equipment supplier and the Reference Test Facility, it is allowed to use a combined solution for the test adaptor. In any case, the performance requirements for the Test Adaptor shall be proven.

6.3.1.2 Its main functions shall be to interact with the reference test architecture modules in those interfaces that are not specified at FFFIS level in the European Specifications.

6.3.1.3 The only mandatory interfaces to be managed by the Test Adaptor shall be the ODO and the TIU.

6.3.1.3.1 In case no On-board Recording Device is provided with the ERTMS/ETCS on-board equipment to be tested, the JRI shall also be mandatory.

6.3.1.4 The management of the CMD and/or the TDA interfaces shall only be mandatory if this functionality is implemented in the ERTMS/ETCS on-board equipment under test.

6.3.2 Functional description

6.3.2.1 For the ODO interface, the ODO-A shall manage the unidirectional communication with the SSS module. It shall get the location, speed and acceleration information from this module as raw data, and shall transfer this information to the ERTMS/ETCS on-board equipment as computable data in the appropriate internal conditions. See chapter 8 for details.

6.3.2.2 For the TIU interface, the TIU-A shall manage the bidirectional communication with the TIS module. It shall read the status of the TIU implemented inputs from the TIS and shall redirect and write this info in the appropriate format to the TIU. In the other direction, it shall read the status of the TIU implemented outputs from the TIU and shall redirect and write this information in the appropriate format to the TIS. The communication shall not be periodic, but produced upon a change on the TIU signal status. See chapter 8 for details.

6.3.2.3 For the JRI interface, the JRI-A shall manage the unidirectional communication with the JRS module. It shall deliver all the juridical information received from the ERTMS/ETCS on-board equipment to the JRS. See chapter 8 for details.

6.3.2.4 For the CMD interface, the CMD-A shall manage the unidirectional communication with the CMS module. It shall get the cold movement detection status from this link and shall transfer this information to the ERTMS/ETCS on-board equipment in the appropriate internal conditions. See chapter 8 for details.

6.3.2.5 For the TDA interface, the TDA-A shall manage the unidirectional communication with the module TDS. It shall get the train data parameters from this link and shall transfer this information to the ERTMS/ETCS on-board equipment in the appropriate internal conditions. See chapter 8 for details.

6.3.2.6 The Test Adaptor shall also receive simulation management commands from the Reference Test Facility through SIM-A. The commands shall include the possibility to start and stop the test and power up and down the ERTMS/ETCS on-board equipment. See chapter 8 for details.

6.3.2.7 Optionally, the Test Adaptor will be capable to create a System Failure condition to the ERTMS/ETCS on-board equipment. This option shall be commanded by the Reference Test Facility through SIM-A.

6.3.3 Performance requirements

6.3.3.1 The performance requirements to be fulfilled by the ERTMS/ETCS on-board equipment are already mentioned in reference [18].

6.3.3.2 The performance requirements for interoperability related to TIU (i.e. brake orders) described in the document [18] shall be made extensive to the TIU-A and to every TIU output. That is, the prescribed maximum delays in [18] shall be measured considering the stop event in the interface between the TIU-A and the TIS module.

6.3.3.3 For the TIU inputs, the TIU Adaptor shall not introduce a delay greater than 200 milliseconds between the reception of data coming from the laboratory module TIS and the transmission of this information to the ERTMS/ETCS on-board equipment.

6.3.3.4 Note: the previous requirement is simply a design request for the Test Adaptor supplier, due to the lack of performance specifications related to the management of TIU inputs by the ERTMS/ETCS on-board equipment.

6.3.3.5 For Cold Movement Detection function in Test Adaptor, no performance requirements are necessary since the data flow from CMS to CMD-A and to the ERTMS/ETCS on-board equipment does not need to be synchronized.

6.3.3.6 For Train Data Acquisition function in Test Adaptor, no performance requirements are necessary since the data flow from TDS to TDA-A and to the ERTMS/ETCS on-board equipment does not need to be synchronized.

6.3.3.7 For the JRI outputs, the JRI-A shall not introduce a delay greater than 500 milliseconds between the reception of data coming from the ERTMS/ETCS on-board equipment and the transmission of this information to the laboratory module JRS.

6.3.3.8 Note: the previous requirement is simply a design request for the Test Adaptor supplier, well below the specified value in document [3], requirement 4.1.1.4.

6.3.3.9 The accuracy requirements related to ODO interface (i.e. position and speed accuracy) described in document [18] shall be respected, taking as reference the position and speed generated by the corresponding laboratory module.

6.4 Reference Test Facility

6.4.1 General issues

6.4.1.1 The test to be performed is described in the LSE.

6.4.1.2 The LSC permits the selection of the Scenario to execute and configures the remaining modules before the simulation starts. The LSC module also performs monitoring tasks during the simulation.

6.4.1.3 The simulation start/stop shall be reported not only to the reference test facility modules, but also to the Test Adaptor.

6.4.1.4 The modules in charge of simulating the train dynamic are the SSS, the TIS and the TMS.

6.4.1.5 The SSS calculates the travelled distance and provides this datum to the relevant modules and the odometry information to the ERTMS/ETCS on-board equipment.

6.4.1.6 The TIS manages the TIU signals (see [4]), including the on-board commands affecting the train dynamics.

6.4.1.7 The TMS calculates the speed and acceleration of the train taking into account the interventions read from the TIU and the predefined speed profile.

6.4.1.8 During the simulation, according to the information included in the Scenario, different inputs shall be sent to the on-board equipment to perform the test, while the outputs shall be managed and recorded.

6.4.1.9 The BTS and the LMS manage Eurobalise and Euroloop messages, respectively, according to the travelled distance.

6.4.1.10 The RMS manages the radio messages exchange (also in fill) according to the travelled distance, time constraints and conditions about having received or sent other messages previously.

6.4.1.11 The SMS manages STM messages according to the same kind of conditions as the RMS.

6.4.1.12 The BTS is connected to the BCS which is the module in charge of producing the signals needed to interface with the on-board equipment through the air gap using the corresponding FFFIS (see [6]).

6.4.1.13 The LMS is connected to the LCS which is the module in charge of producing the signals needed to interface with the on-board equipment through the air gap using the corresponding FFFIS (see [8]).

6.4.1.14 The SMS is connected to the SCS which will add all the layers needed to the messages and will send and receive them through a profibus connection, as described in the FFFIS (see [5], [10] & [1]).

6.4.1.15 The RMS is connected to the RCS.This module is connected to the on-board equipment using the interface with the on-board GSM-R mobile equipment, as described in the FFFIS (see [9]). This module also manages the AT commands exchange in the configuration phase (see [9]), and the data encryption/de-encryption in the data transmission phase (see [7]).

6.4.1.16 The DIS module shall record the information displayed on the DMI. Due to the lack of specifications for the DMI internal interface, the DMI inputs described in Subset-076 Test Sequences will be introduced directly on the DMI interface (see [19]).

6.4.1.17 If needed (see 6.2.1.4.2), the JRS shall record the juridical ETCS information during the simulation.

6.4.1.18 If needed (see 5.1.1.8.1) and required by the scenario, the TDS shall provide the train data to the Test Adaptor, at least once, before the ERTMS/ETCS on-board equipment is powered up.

6.4.1.19 If needed (see 5.1.1.8.1) and required by the scenario, the CMS shall provide the cold movement information to the Test Adaptor before the ERTMS/ETCS on-board equipment is powered up.

6.4.1.20 The LER collects data from the laboratory modules while the simulation takes place.

6.4.1.21 Once the simulation has finished and all the information from the ERTMS/ETCS on-board equipment has been retrieved by the test facility modules, they can be accessed by the AET, which shall compare the logged data with the Test Sequence description and produce a report with the estimated results.

6.4.1.22 Many of the previous modules require interacting with the test operator (user). In the following sections it shall be specified the mandatory user interface functions associated to every module. However, it is out of the scope of this document to mandate a specific implementation of the graphical user interfaces.

6.4.1.23 In the following sections, every module in Figure 1 is described in detail, from a functional point of view. Performance requirements have been added where considered

critical for the simulation. For any other case, the only request is the integrity of the information to be transferred from one module to other.

6.4.2 Laboratory Scenario Editor (LSE)

6.4.2.1 Functional description

6.4.2.1.1 This module shall allow managing the scenarios to be used in the simulation. It shall implement as basic functions to create, edit, delete and save a scenario.

6.4.2.1.2 This module shall allow accessing all the information included in the Subset-076-6-3 Test Sequences databases.

6.4.2.1.3 For the remaining information of the scenario, as defined in 6.1.1.2, this module shall provide the means to create, edit, delete and save such information.

6.4.2.1.4 This module shall also permit to define simulation details (e.g. list of modules to be used during the simulation and their configuration options) for every scenario.

6.4.2.1.5 Once all the information is completed and the scenario is saved, it shall be stored into data sets that shall be available for the other modules for a proper testing.

6.4.2.1.6 Optionally, this module can provide some correctness checks in order to avoid undesired mismatches among all the data to be used for a proper simulation.

6.4.2.2 Performance requirements

6.4.2.2.1 Since this module is used prior to any simulation, it does not need to fulfil special requirements in terms of performance.

6.4.3 Laboratory Scenario Controller (LSC)

6.4.3.1 Functional description

6.4.3.1.1 This module shall manage the synchronization with the modules interfacing the ERTMS/ETCS on-board equipment under test and with the Test Adaptor.

6.4.3.1.2 During the simulation, this module shall perform surveillance tasks to control the right behaviour of the laboratory modules involved.

6.4.3.1.3 The mandatory user interface functions for this module are related to the simulation management. At least, it shall be possible to select the scenario, start,/stop the simulation and power up/down the ERTMS/ETCS on-board equipment.

6.4.3.1.3.1 Optionally, it will be possible to send a signal to the Test Adaptor in order to generate a System Failure condition to the ERTMS/ETCS on-board equipment.

6.4.3.1.4 The optional user interface functions for this module are related to the display of general information during the simulation run, retrieved by the modules interfacing the ETCS on-board equipment under test. This general information comprises, at least, the train speed and location, TIU status and messages exchanged through Eurobalise, euroradio, Euroloop or STM interface.

6.4.3.1.5 Optionally, graphical user interface for specific actions related to the train simulation. Specifically, starting the train movement (SSS) and management of TIU inputs (cab activation, direction controller, etc).

6.4.3.2 **Performance requirements**

6.4.3.2.1 As this module is in charge of controlling and monitoring the simulation, it must handle several communication links. Although the information exchanged is not time critical for the simulation, it is recommended a real time implementation in order to guarantee a predictable and faulty-free behaviour.

6.4.4 Train Interface Simulator (TIS)

6.4.4.1 **Functional description**

6.4.4.1.1 The TIS will account for the communication with the Test Adaptor related to Train Interface data. This communication shall be bidirectional and shall cover all the train interface information mentioned on [2] and [4], even when the ERTMS/ETCS on-board interface does not implement part of this information. It is the responsability of the TIU-A to filter out this kind of information in its communication with the ERTMS/ETCS on-board equipment.

6.4.4.1.1.1 Note: the data included in this section is the minimum set affected by the ETCS specifications in [2] and [4], although traditionally, the interface with the train can include more information. To extend the train interface beyond the data set here described is an implementation detail, out of the scope of this specification.

6.4.4.1.2 The TIU inputs status (i.e. generated by TIS) shall be transferred to the TIU-A once, before the ERTMS/ETCS on-board equipment is powered up. Later on, when the scenario is running, TIS shall only update this information upon change.

6.4.4.1.3 A set of TIU inputs are just the feedback to the ERTMS/ETCS on-board equipment of equivalent TIU outputs. That is, this set of TIU data can be classified as dependent data and their status shall be affected by the changes on their equivalent TIU output.

6.4.4.1.4 For the dependent TIU inputs the TIS module behaviour shall be configurable, that is, it shall be possible to predefine an specific reaction time for the update of every TIU input after the change detected in the corresponding TIU output. It shall also be possible to program a faulty behaviour (i.e. the TIU input is not updated after the change in the TIU output).

6.4.4.1.5 The dependent TIU inputs are:

a) Special brakes status.

b) Traction status.

6.4.4.1.6 The other set of TIU input data are independent (e.g. desk open/close, sleeping signal, etc). The change in the status of this kind of TIU input data shall be driven manually (through a graphical user interface) or automatically, following the scenario description related to the TIU information exchange in time and location.

6.4.4.1.7 The independent TIU inputs are:

a) Sleeping.

b) Passive Shunting.

c) Direction Controller Position.

d) Cab status.

e) Train Integrity.

f) Non Leading.

g) Additional brake status.

h) Brake pressure.

i) Type of train data entry.

j) Train data.

6.4.4.1.8 Note: the following independent TIU inputs affect the train dynamic simulation and shall be managed accordingly:

a) Direction controller position.

b) Cab status.

c) Additional brake status.

6.4.4.1.9 The TIS module, when detecting a change on this set of TIU inputs, shall report this information to the TMS module.

6.4.4.1.10 The TIU outputs status shall be transferred from the TIU-A to the TIS once, before the ERTMS/ETCS on-board equipment is powered up. Later on, when the scenario is running, the TIU-A shall only update this information if their status is modified by the ERTMS/ETCS on-board equipment.

6.4.4.1.11 The TIU outputs can be classified in two groups: TIU outputs affecting the train dynamic simulation (e.g. the service brake) or not (e.g. air tightness).

6.4.4.1.12 The TIS module, when detecting a change on the first set of TIU outputs, shall report this information to the Train Motion Simulator module.

6.4.4.1.13 Note: The following TIU outputs affects the train dynamic simulation and shall be managed accordingly:

a) Service Brake.

b) Emergency Brake.

c) Regenerative Brake Inhibition.

d) Magnetic Shoe Brake Inhibition.

e) Eddy Current Brake for SB Inhibition.

f) Eddy Current Brake for EB Inhibition.

g) Change of Traction Power.

h) Pantograph.

i) Main power switch.

j) Traction Cut-off.

k) Current Consumption.

6.4.4.1.14 Secondly, in case the TIU output updated has an equivalent feedback TIU input, TIS shall proceed to update the corresponding signal, respecting the programmed delay.

6.4.4.1.15 All the information exchanged between the TIS and the TIU-A shall be reported to the LER with the corresponding timestamp and location. The module status information shall be reported as well.

6.4.4.1.16 The mandatory user interface functions for this module are related to the management of the independent TIU inputs. It shall be possible to modify the status of this information during the simulation.

6.4.4.2 **Performance requirements**

6.4.4.2.1 The most critical information to be taken into account is the set of TIU outputs affecting the train dynamic simulation.

6.4.4.2.2 The maximum delay between the detection of a change in the status of the TIU output affecting the train dynamic simulation and the availability of this information for the Train Motion Simulator module shall be 200 milliseconds.

6.4.4.2.3 Note: the proposed value is well below the brake reaction time (in the seconds range) , also bounded by limits to be found on the TSI relating to the Rolling Stock sub-system.

6.4.4.2.4 For this module a real time implementation is requested.

6.4.4.3 **Interface description**

6.4.4.3.1 A detailed proposal for this interface is provided in chapter 8.

6.4.5 Speed Sensor Simulator (SSS)

6.4.5.1 **Functional description**

6.4.5.1.1 The SSS will account for the communication with the Test Adaptor related to Odometry data. This communication shall be unidirectional and shall be performed either on a cyclic basis, or in a continuous way.

6.4.5.1.2 This module shall provide speed and acceleration to the ODO-A.

6.4.5.1.3 All these information shall be updated periodically by the TMS.

6.4.5.1.4 This module shall calculate the train location from the dynamic data provided by the TMS.

6.4.5.1.5 The train location shall be updated periodically by the SSS. This data shall be available for the remaining modules included in the reference test architecture.

6.4.5.1.6 The SSS time cycle for the location calculation shall be an integer divisor of the TMS time cycle. Note: the distance change rates are higher than the speed change rates.

6.4.5.1.7 This module shall report to the LER the location information with timestamp on a cyclic basis. The module status information shall be reported as well.

6.4.5.2 **Performance requirements**

6.4.5.2.1 The time cycle for the SSS location calculation shall be at least of 100 milliseconds.

6.4.5.2.2 In case the odometry data is transmitted cyclically to the ODO-A, this communication cycle shall be identical to the time cycle used for the location calculation.

6.4.5.2.3 In case the odometry data is transmitted continuously to the ODO-A, the generated speed shall not deviate more than 1% from the theoretical speed.

6.4.5.2.4 The time cycle for reporting location information to LER module shall be a multiple of the previous time cycle not bigger than 20 (10 is recommended, i.e. 1 second).

6.4.5.2.5 In order to avoid undesired drifts in this time cycle, for this module a real time implementation is requested.

6.4.5.2.6 Further details on performance and accuracy are provided in chapter 8.

6.4.5.3 **Interface description**

6.4.5.3.1 A detailed proposal for both cyclic and continuous transmission of odometric data through this interface is provided in chapter 8.

6.4.6 Cold Movement Sensor Simulator (CMS)

6.4.6.1 **Functional description**

6.4.6.1.1 The CMS shall account for the communication with the Test Adaptor related to cold movement data.

6.4.6.1.2 This communication shall be unidirectional and shall be performed once, at the beginning of the scenario, before the ERTMS/ETCS on-board equipment is powered up.

6.4.6.1.3 This module shall provide one of the following status information to the Test Adaptor: not available, train has moved, train has not moved or fail state.

6.4.6.1.4 All the information exchanged between the CSS and the CMD Adaptor shall be reported to the LER with the corresponding timestamp and location. The module status information shall be reported as well.

6.4.6.2 **Performance requirements**

6.4.6.2.1 Since the data flow from CMS to CMD-A and to the ERTMS/ETCS on-board equipment does not need to be synchronized, CMS does not need to fulfil special requirements in terms of performance.

6.4.6.3 **Interface description**

6.4.6.3.1 A detailed proposal for this interface is provided in chapter 8.

6.4.7 Train Data Simulator (TDS)

6.4.7.1 **Functional description**

6.4.7.1.1 The TDS shall account for the communication with the Test Adaptor related to the functionality *train data acquisition from external devices*.

6.4.7.1.2 This communication shall be unidirectional and shall be performed at least once, at the beginning of the scenario, before the ERTMS/ETCS on-board equipment is powered up.

6.4.7.1.3 During the simulation run, if the scenario requests a new delivery. this module shall manage to execute more transmissions (with the same data or modified). These new deliveries shall be driven manually (through a graphical user interface) or automatically, following the scenario description related to the train data exchange in time and location.

6.4.7.1.4 All the information exchanged between the TDS and the TDA-A shall be reported to the LER with the corresponding timestamp and location. The module status information shall be reported as well.

6.4.7.2 **Performance requirements**

6.4.7.2.1 Since the data flow from TDS to TDA-A and to the ERTMS/ETCS on-board equipment does not need to be synchronized, TDS does not need to fulfil special requirements in terms of performance.

6.4.7.3 **Interface description**

6.4.7.3.1 A detailed proposal for this interface is provided in chapter 8.

6.4.8 Train Motion Simulator (TMS)

6.4.8.1 **Functional description**

6.4.8.1.1 The TMS, on a cyclic basis, calculates the train speed, acceleration and main pipe pressure in real time, taking into account by one side the train parameters and the speed profile defined in the scenario and by the other side, the status of different TIU data.

6.4.8.1.2 The first set of information (train parameters and predefined speed profile) shall be loaded in the configuration phase.

6.4.8.1.3 The second set of data (TIU information) shall be considered once the simulation is running.

6.4.8.1.4 This module shall take into account the following TIU data:

a) Emergency Brake Command.

b) Service Brake Command.

c) Regenerative Brake Inhibition.

d) Eddy Current Brake Inhibition.

e) Magnetic Shoe Brake Inhibition.

f) Change of Traction System.

g) Allowed Current Consumption.

h) Traction Cut off.

i) Pantograph up/down.

j) Main power switch open/closed.

k) Cab Status.

l) Direction Controller.

6.4.8.1.5 For a correct dynamic simulation, this module shall use the train location data provided by the Speed Sensor Simulation periodically.

6.4.8.1.6 This module shall provide the dynamic information (speed, acceleration and main pipe pressure) periodically to the other modules on the reference test architecture.

6.4.8.1.7 The TMS shall use for its calculation an integer multiple of the SSS time cycle.

6.4.8.1.8 This module shall report to the LER the odometry information with timestamp and location on a cyclic basis. The module status information shall be reported to the LER as well.

6.4.8.2 **Performance requirements**

6.4.8.2.1 The time cycle for TMS calculations is recommended to be 2 times the SSS time cycle (i.e. 200 milliseconds, if the upper limit provided in section 5.3.6.2 is used).

6.4.8.2.2 The time cycle for reporting odometry information to LER module shall be a multiple of the previous time cycle not bigger than 10 (5 is recommended, i.e. 1 second).

6.4.8.2.3 In order to avoid undesired drifts in the time cycle, for this module a real time implementation is requested.

6.4.9 Balise Telegram Simulator (BTS)

6.4.9.1 **Functional description**

6.4.9.1.1 This module shall manage the list of balise telegrams described in the scenario.

6.4.9.1.2 Note: whether this list is loaded in the configuration phase or updated dynamically as the simulation runs is an implementation detail out of the scope of this document.

6.4.9.1.3 The list of balise telegrams shall include the balise location.

6.4.9.1.4 Note: whether this list is arranged by single balise telegrams or by Balise Groups (identifying the number of balises within each group and the separation between them) is an implementation detail out of the scope of this document.

6.4.9.1.5 This module shall manage the communication with the BCS in such a way the performance requirements for BCS are respected.

6.4.9.1.6 This module shall report to the LER the delivery of a balise telegram with timestamp and location. The module status information shall be reported to the LER as well.

6.4.9.2 **Performance requirements**

6.4.9.2.1 For a proper testing, the location accuracy to be managed by this module shall be better than 0,1 metres.

6.4.9.2.2 Additional requirements shall be provided in the module BCS section.

6.4.10 Loop Message Simulator (LMS)

6.4.10.1 **Functional description**

6.4.10.1.1 This module shall manage the list of Euroloop messages described in the scenario.

6.4.10.1.2 Note: whether this list is loaded in the configuration phase or updated dynamically as the simulation runs is an implementation detail out of the scope of this document.

6.4.10.1.3 The list of Euroloop messages shall include the Euroloop start and stop location and the key Q_SSCODE (see [2]) to be used for the correct loop signal generation.

6.4.10.1.4 This module shall manage the communication with the LCS in such a way the performance requirements for LCS are respected.

6.4.10.1.5 This module shall report to the LER the start location for the delivery of a loop message, the stop location and the loop message delivered (with timestamp and location). The module status information shall be reported to the LER as well.

6.4.10.2 **Performance requirements**

6.4.10.2.1 For a proper testing, the location accuracy to be managed by this module shall be better than 0,1 metres.

6.4.10.2.2 Additional requirements shall be provided in the module LCS section.

6.4.11 Radio Message Simulator (RMS)

6.4.11.1 **Functional description**

6.4.11.1.1 This module shall simulate the trackside safe application (RBC or Radio in-fill unit).

6.4.11.1.2 This module shall be able to simulate, at least, two trackside safe applications.

6.4.11.1.3 This module shall interface to the RCS through the safe service primitives defined in ref. [7].

6.4.11.1.4 Note: the safe services primitives are intended to support the safe connection set-up, the safe data transfer, the safe connection release, error reporting and high priority data.

6.4.11.1.5 All the safe service primitives shall be managed properly (e.g. considering the ETCS ID included in the primitives), but the safe service primitives for error reporting, which shall be considered as optional.

6.4.11.1.6 This module shall manage the complete list of safe service primitives to be delivered to the ERTMS/ETCS on-board equipment (through the RCS module) described in the scenario.

6.4.11.1.7 Note: whether this list is loaded in the configuration phase or updated dynamically as the simulation runs is an implementation detail out of the scope of this document.

6.4.11.1.8 The list of safe services primitives shall include the following information for every primitive: location, delay and condition.

6.4.11.1.9 In case the safe primitive is for data transfer (normal or high priority), it shall also be attached the ETCS radio message (See [2]), as defined in the scenario.

6.4.11.1.10 The safe connection status shall be checked prior to any data transfer.

6.4.11.1.11 The location shall be used as the first trigger condition for sending safe services primitives.

6.4.11.1.12 The delay time shall be considered as the second trigger condition and shall start when the first trigger condition (location) is fulfilled.

6.4.11.1.13 It shall be possible to make the safe services primitive delivery conditional on the reception of a previous safe service primitive in a given time window.

6.4.11.1.14 Moreover, it shall be possible to make the delivery conditional on the reception of a specific ETCS radio message in a given time window.

6.4.11.1.15 It shall manage the ETCS radio messages timestamp (T_TRAIN) in real time, according to the test sequences description and restrictions.

6.4.11.1.16 It shall also manage dependent variables in the ETCS radio messages (variables that depend on previous messages delivered by the ERTMS/ETCS on-board equipment).

6.4.11.1.17 For a correct dynamic simulation, this module shall use the train location data provided by the SSS periodically.

6.4.11.1.18 The time cycle to be used by this module shall be an integer multiple of the SSS time cycle. In any case, in order to improve the accuracy of this module at very high speed simulation, it is recommended to use a configurable time cycle.

6.4.11.1.19 This module shall report to the LER the delivery and reception of every safe service primitive with timestamp and location. The module status information shall be reported to the LER as well.

6.4.11.2 **Performance requirements**

6.4.11.2.1 The RMS time cycle is recommended to be 2 times the SSS time cycle (i.e. 200 milliseconds, if the upper limit provided in section 6.4.6.2 is used).

6.4.11.2.2 The maximum delay for RMS to deliver a safe service primitive from the first trigger condition shall be 500 ms.

6.4.11.2.3 In order to avoid undesired drifts in the time cycle, for this module a real time implementation is requested.

6.4.11.2.4 Additional requirements shall be provided in the module RCS section.

6.4.12 STM Messages Simulator (SMS)

6.4.12.1 **Functional Description**

6.4.12.1.1 This module shall manage the STM messages received from the ERTMS/ETCS on-board equipment (through the SCS).

6.4.12.1.2 This module shall manage the list of STM messages to be delivered to the ERTMS/ETCS on-board equipment (through the SCS) described in the scenario.

6.4.12.1.3 Note: whether this list is loaded in the configuration phase or updated dynamically as the simulation runs is an implementation detail out of the scope of this document.

6.4.12.1.4 The STM messages shall fulfil ref. [12].

6.4.12.1.5 The list of STM messages shall include the following information for every message: location, delay and condition.

6.4.12.1.6 The location shall be used as the first trigger condition for sending STM messages.

6.4.12.1.7 The delay time shall be considered as the second trigger condition and shall start when the first trigger condition (location) is fulfilled.

6.4.12.1.8 It shall be possible to make the STM message delivery conditional on the reception of a previous STM message in a given time window.

6.4.12.1.9 It shall be able to manage the list of messages of, at least, one STM.

6.4.12.1.10 For a correct dynamic simulation, this module shall use the train location data provided by the SSS periodically.

6.4.12.1.11 The time cycle to be used by this module shall be an integer multiple of the SSS time cycle. In any case, in order to improve the accuracy of this module at very high speed simulation, it is recommended to use a configurable time cycle.

6.4.12.1.12 This module shall report to the LER the delivery and reception of every STM message with timestamp and location. The module status information shall be reported to the LER as well.

6.4.12.2 **Performance requirements**

6.4.12.2.1 The SMS time cycle is recommended to be 2 times the SSS time cycle (i.e. 200 milliseconds, if the upper limit provided in section 6.4.6.2 is used).

6.4.12.2.2 The maximum delay for SMS to deliver a STM message from the first trigger condition shall be 500 ms.

6.4.12.2.3 In order to avoid undesired drifts in the time cycle, for this module a real time implementation is requested.

6.4.12.2.4 Additional requirements shall be provided in the module SCS section.

6.4.13 Laboratory Event Recorder (LER)

6.4.13.1 **Functional description**

6.4.13.1.1 This module shall manage the logging information sent by all the reference test facility modules participating in the simulation.

6.4.13.1.2 The logging information shall be organized by simulation (i.e. scenario run).

6.4.13.1.3 The entries shall be identified by the name of the module sending the information.

6.4.13.2 **Performance requirements**

6.4.13.2.1 Since this module is not critical for the simulation, it does not need to fulfil special requirements in terms of performance.

6.4.14 Radio Communication Simulator (RCS)

6.4.14.1 **Functional description**

6.4.14.1.1 It shall emulate at least two GSM-R mobile terminals, at physical and logical level (fully compliant with ref. [9]). The behaviour at logical level shall be programmable and shall include the registration in radio networks.

6.4.14.1.2 With the GSM-R connection established, it shall implement the euroradio protocols described in ref. [7] (It shall be possible to modify the parameters described as optional or configurable in this document).

6.4.14.1.3 This module shall manage an editable table of Keys (Kmac) for encryption, together with the ETCS ID couples (trackside and on-board equipment) affected.

6.4.14.1.4 Finally, for the interface with the RMS, the RCS shall be a Safe Services Provider (see [7]).

6.4.14.1.5 Taking into account the requirements on the RMS, the RCS shall be able to provide as many Safe Services Access Points as Safe Applications are implemented in the RMS.

6.4.14.1.6 This module shall allow generating connection losses at predefined locations and distances. It shall manage predefined radio hole sections.

6.4.14.2 **Performance requirements**

6.4.14.2.1 In order to avoid undesired drifts in the time cycle, for this module a real time implementation is requested.

6.4.14.3 **Interface description**

6.4.14.3.1 For the physical connection with the ERTMS/ETCS on-board equipment, V.11/RS-422 shall be used (see [9]).

6.4.14.3.2 Some additional recommendations are given in chapter 9.

6.4.15 Juridical Recording Simulator (JRS)

6.4.15.1 **Functional description**

6.4.15.1.1 The JRS shall account for the communication with the Test Adaptor related to the functionality *juridical data recording*.

6.4.15.1.2 This communication shall be unidirectional, from the ERTMS/ETCS on-board equipment to the JRS, through the JRI-A.

6.4.15.1.3 All the information exchanged between the JRI-A and the JRS shall be reported to the LER with the corresponding timestamp and location. The module status information shall be reported as well.

6.4.15.2 **Performance requirements**

6.4.15.2.1 In order to avoid undesired drifts in this time cycle, for this module a real time implementation is requested.

6.4.15.3 **Interface description**

6.4.15.3.1 A detailed proposal for this interface is provided in chapter 8.

6.4.15.3.2 The application messages shall be compliant to reference [3].

6.4.16 Balise Communication Simulator (BCS)

6.4.16.1 **Functional description**

6.4.16.1.1 It shall generate in the right time and format the balise telegram (fully compliant with ref. [6]).

6.4.16.1.2 The balise telegram shall be modulated with a balise shape which width shall depend on the speed.

6.4.16.1.3 It shall manage at least two different separation distances within the balise groups.

6.4.16.2 **Performance requirements**

6.4.16.2.1 This module shall be able to dispatch telegrams within the limits described in ref. [17] for the balise positioning at the maximum train speed (500 Km/h).

6.4.16.3 **Interface description**

6.4.16.3.1 The balise telegram shall be delivered to the ERTMS/ETCS on-board equipment through the air-gap, fully described in ref. [6].

6.4.16.3.2 Some simulation choices (balise shape, power level, test balise description) are provided in chapter 10.

6.4.17 Loop Communication Simulator (LCS)

6.4.17.1 **Functional description**

6.4.17.1.1 It shall generate in the right time and format the Euroloop message (fully compliant with ref. [8]).

6.4.17.1.2 The message shall be encrypted using the corresponding Q_SSCODE, as specified in the Test Sequence.

6.4.17.2 **Performance requirements**

6.4.17.2.1 This module shall be able to dispatch loop messages within the limits described in ref. [17] for the Euroloop positioning at the maximum train speed (500 Km/h).

6.4.17.3 **Interface description**

6.4.17.3.1 The loop message shall be delivered to the ERTMS/ETCS on-board equipment through the air-gap, fully described in ref. [8].

6.4.18 STM Communication Simulator (SCS)

6.4.18.1 **Functional description**

6.4.18.1.1 It shall emulate the communication layer of an STM, at physical and logical level (compliant with ref. [5]).

6.4.18.1.2 It shall apply the protocols described in ref. [10] (Safe Time Layer STM FFFIS) and ref. [11] (Safe Link Layer STM FFFIS) for encoding/decoding the STM application messages to be delivered/received to/from the ERTMS/ETCS on-board equipment.

6.4.18.1.3 The PROFIBUS configuration shall be editable.

6.4.18.2 **Performance requirements**

6.4.18.2.1 Ref. [20] shall be used for performance requirements of the module.

6.4.18.3 **Interface description**

6.4.18.3.1 The messages exchange with the ERTMS/ETCS on-board equipment shall be done through a profibus interface, as defined in ref. [5].

6.4.19 DMI Interface Simulator (DIS)

6.4.19.1 **Functional description**

6.4.19.1.1 It shall record every input and output on the DMI device in digital format.

6.4.19.1.2 It shall be synchronized with the lab tools.

6.4.19.1.3 Optionally, it shall manage in an autonomous way the DMI inputs described in the Test Sequence, permitting in this way an automatic simulation with no operator.

6.4.19.1.4 By default, the DMI inputs shall be introduced manually, by trained staff, following specific procedures for every scenario.

6.4.19.2 **Performance requirements**

6.4.19.2.1 In order to avoid undesired drifts in the time cycle, for this module a real time implementation is recommended.

6.4.19.2.2 In case the automatic DMI inputs are implemented, the real time implementation shall be requested.

6.4.20 Automatic Evaluation Tool (AET)

6.4.20.1 Functional description

6.4.20.1.1 This is an off line module used to compare the data logged during the simulation with the expected behaviour of the ERTMS/ETCS on-board equipment described in the Test Sequences (ref. [14]).

6.4.20.1.2 The data logged shall comprise the data recorded by LER and the data recorded by DIS.

6.4.20.1.3 In order to ease that comparison, this module shall allow translating the generic description included in ref. [14] into a clear defined observable.

6.4.20.1.4 The observables shall be directly traced to a specific record within the whole set recorded by the different reference test facility modules.

6.4.20.1.5 The comparison mechanism shall be in fact a search of the defined observable within the Test Sequence description in the correct time and location window.

6.4.20.1.6 The automatic evaluation shall provide additional algorithms in order to avoid duplicated matches and solve the dependencies among consecutive steps.

7. SYSTEM INTEGRITY AND VALIDATION

7.1.1.1 The implementation of a test facility shall be used to test an ERTMS/ETCS on-board equipment which shall be SIL 4, although it can include components with a lower SIL.

7.1.1.2 The test facility shall be calibrated before and after testing an ERTMS/ETCS on-board equipment. The calibration shall be done according to the laboratories own procedures.

8. REFERENCE TEST FACILITY INTERFACES

8.1 Introduction

8.1.1.1 This section describes in detail the interfaces of the Reference Test Facility modules with the ERTMS/ETCS on-board equipment.

8.1.1.2 The information here provided is complementary to the existing specifications. Table 4 summarizes the specifications affecting to every interface. The level of detail can be classified as:

a) In cases where the available specifications reach the functional form fit level (ex, the Eurobalise interface), this section shall simply provide some implementation details.

b) In cases where the available specifications reach only the functional level (ex, the TIU interface), this section shall provide the form fit part.

c) In cases where no interface specification is available (ex. the internal functions, like *odometry*), this section shall provide a functional form fit specification.

8.1.1.3 Only in case a), the Reference Test Facility shall communicate directly with the ERTMS/ETCS on-board equipment. In cases b) and c) the communication shall be through the Test Adaptor.

8.1.1.3.1 Note: the interfaces through the Test Adaptor (case b) and c)) shall be called Test Interfaces.

8.1.1.4 The data classified as Input shall be transmitted from the Reference Test Facility to the Test Adaptor.

8.1.1.5 The data classified as Output shall be transmitted from the Test Adaptor to the Reference Test Facility.

8.1.1.6 For the communication with the Test Adaptor, two main technologies are recommended: digital I/O and bus driven communication.

8.1.1.7 Only bus driven communication covers completely all the interfaces with the Test Adaptor. However, digital I/O is still recommended, where suitable, since its performance is better and it also simplifies the ERTMS/ETCS on-board equipment integration into the test facility.

8.1.1.8 For the bus driven communication, a complete application layer (messages and variables) is defined within this section. For the lower communication layers, detailed technologies are recommended, depending on the interface.

8.1.1.9 For the digital I/O communication, detailed technologies at physical level are recommended, depending on the interface.

8.1.1.10 For the particular case of the TIU interface, and following the TIU data classification in [4], it has been decided to split the information exchanged in five blocks, described in Table 5.

Table 5: TIU interface blocks

Name	Description	I/O

TIU-1	Mode control and Train status info	Input and Output
TIU-2	Control of brakes info	Input and Output
TIU-3	Train data info	Input
TIU-4	Train functions type I	Output
TIU-5	Train functions type II	Output

8.1.1.11 Taking into account Table 5 and the remaining interfaces, in Table 6 it is summarized the complete set of interfaces with the Test Adaptor, the suitable technologies for implementation in the reference test facility and its use, depending on the particular implementation of the ERTMS/ETCS on-board equipment.

Table 6: Test Interfaces description.

Name	Description	Digital I/O	Bus	Use
CMD	Cold Movement Detection	Yes	Yes	If implemented
ODO	Odometry interface	Yes	Yes	Mandatory
JRI	Juridical Recording Interface	No	Yes	See 6.2.1.4.2
SIM	Simulation Management	Yes	Yes	Mandatory
TDA	Train Data Acquisition through external sources	No	Yes	If implemented
TIU-1	Mode control and Train status	Yes	Yes	Mandatory
TIU-2	Control of brakes	Yes	Yes	Mandatory
TIU-3	Train data	No	Yes	If implemented
TIU-4	Train functions type I	Yes	Yes	Mandatory
TIU-5	Train functions type II	No	Yes	If implemented

8.1.1.12 The specific implementation of a reference test facility shall decide which technology will be used for every specific ERTMS/ETCS on-board equipment. It is out of the scope of this specification to mandate an specific choice for the test interfaces.

8.1.1.13 Independently of the choice for the Test Interfaces, once the ERTMS/ETCS on-board equipment is connected and ready for testing, the test facility shall prove, following its internal procedures, that the performance requirements included in this document are fulfilled.

8.2 Digital Input/Output technology

8.2.1 CMD interface

8.2.1.1 **Physical characteristics**

8.2.1.1.1 The signal exchange shall work on a range of 0-24 Volts and shall be optically isolated.

8.2.1.1.2 Logical 0 corresponds to 0 Volts, while logical 1 corresponds to 24 Volts.

8.2.1.2 **Signals summary**

8.2.1.2.1 Only one physical input signal is needed to transfer this information, with the meaning indicated in Table 7.

Table 7: CMD digital input meaning.

Data	Logical 0	Logical 1
Cold Movement Detection	Train has moved	Train has not moved

8.2.2 ODO interface

8.2.2.1 Physical characteristics

8.2.2.1.1 The odometry digital interface shall consist, by one side, on a main square waveform signal. Each period of this signal represents a distance increment. Dividing this distance by the elapsed time, the real speed of the train can be obtained.

8.2.2.1.2 The square wave frequency is, thus, proportional to the speed of the train, according to the following equation:

$$Frequency = \frac{Speed}{I}$$, where I is the increment of distance;

8.2.2.1.3 For the direction information, another signal is needed. This second signal could be a digital signal (0 forward and 1 backward) or the same incremental signal as the first one but with a difference of phase of plus or minus 90 degrees.

8.2.2.1.4 The I parameter will be configurable to some extend. If a too high or a too low value is chosen, the frequency could result in a strange value to be produced by the hardware. The highest value of the frequency of the square signal will be 10 KHz. If the train is moving at 500 Km/h (v=138.9 m/s, worst case scenario), the diameter of the wheel is 1 m (D=1m), and the wheel has 20 teeth (k=20), the frequency needed would be:

$$f = \frac{k \cdot v}{\pi \cdot D} = 884Hz$$

8.2.2.1.5 Although 1 KHz would be enough for a typical case, having a maximum value of 10 KHz ensures that strange combinations of diameter of the wheel and number of teeth will be able to be reproduced in the test facility.

8.2.2.1.6 With this value, for example, if the train is running at 100 m/s (360 Km/h) the increment would be:

$$I = \frac{v}{f} = \frac{100m/s}{10000Hz} = 1cm$$, which is accurate enough.

8.2.2.1.7 The way in which the direction is given will also be configurable. There are two possibilities:

a) Digital output signal:
   i. Logical 0: forward.
   ii. Logical 1: backward.

b) Same incremental signal as the first one but with a difference of phase:
   i. + 90º: forward.

ii. - 90º: backward.

8.2.2.1.8 The voltage amplitude of the signals shall be TTL (from 0 to 5 Volts).

8.2.2.1.9 Logical 0 corresponds to 0 Volts, while logical 1 corresponds to 5 Volts.

8.2.3 SIM interface

8.2.3.1 Physical characteristics

8.2.3.1.1 The signal exchange shall work on a range of 0-24 Volts and shall be optically isolated.

8.2.3.1.2 Logical 0 corresponds to 0 Volts, while logical 1 corresponds to 24 Volts.

8.2.3.2 Signals summary

8.2.3.2.1 The signals associated to this interface are summarized in Table 8.

Table 8: SIM interface digital signals.

Data	I/O	Nr. physical signals
Start/stop the test	Input	1
Power up/down the on-board equipment	Input	1
System Failure condition	Input	1

8.2.3.2.2 The data encoding is described in Table 9.

Table 9: SIM digital inputs meaning.

Data	Logical 0	Logical 1
Start/stop the test	Start test	Stop test
Power up/down the on-board equipment	Power up on-board equipment	Power down on-board equipment
System Failure condition	Enable SF condition	Disable SF condition

8.2.4 TIU interface

8.2.4.1 Physical characteristics

8.2.4.1.1 The signal exchange shall work on a range of 0-24 Volts and shall be optically isolated.

8.2.4.1.2 Logical 0 corresponds to 0 Volts, while logical 1 corresponds to 24 Volts.

8.2.4.2 Signals summary

8.2.4.2.1 The signals associated to this interface are summarized in Table 10.

Table 10: TIU interface digital signals.

Data	I/O	Nr. physical signals
(TIU-1) Sleeping	Input	1
(TIU-1) Passive Shunting	Input	1
(TIU-1) Non Leading	Input	1
(TIU-1) Cab (Desk) A Status	Input	1
(TIU-1) Cab (Desk) B Status	Input	1
(TIU-1) Direction Controller Position	Input	2

(TIU-1) Train Integrity	Input	1
(TIU-1) Traction Status	Input	1
(TIU-1) Isolation	Output	1
(TIU-2) Service Brake command	Output	1
(TIU-2) Emergency Brake command	Output	1
(TIU-2) Regenerative Brake inhibition	Output	1
(TIU-2) Magnetic Shoe Brake inhibition	Output	1
(TIU-2) Eddy Current Brake for SB inhibition	Output	1
(TIU-2) Eddy Current Brake for EB inhibition	Output	1
(TIU-2) Regenerative Brake status	Input	1
(TIU-2) Magnetic Shoe Brake status	Input	1
(TIU-2) Eddy Current Brake status	Input	1
(TIU-2) Electro-pneumatic Brake status	Input	1
(TIU-2) Additional Brake status	Input	1
(TIU-2) Brake pressure	Input	6
(TIU-4) Pantograph	Output	1
(TIU-4) Air Tightness	Output	1
(TIU-4) Main power switch	Output	1
(TIU-4) Traction Cut-off	Output	1

8.2.4.2.2 The encoding of data with just one physical signal is described in Table 11.

Table 11: TIU data with 1 physical signal meaning.

Data	Logical 0	Logical 1
(TIU-1) Sleeping	Sleeping requested	Sleeping not requested
(TIU-1) Passive Shunting	Passive shunting permitted	Passive shunting not permitted
(TIU-1) Non Leading	Non leading permitted	Non leading not permitted
(TIU-1) Cab (Desk) A Status	Cab A active	Cab A not active
(TIU-1) Cab (Desk) B Status	Cab B active	Cab B not active
(TIU-1) Train Integrity	Train integrity OK	Train integrity lost
(TIU-1) Traction Status	Traction On	Traction Off
(TIU-1) Isolation	On-board equipment isolated	On-board equipment not isolated
(TIU-2) Service Brake command	SB commanded	SB not commanded
(TIU-2) Emergency Brake command	EB commanded	EB not commanded
(TIU-2) Regenerative Brake inhibition	Regenerative brake inhibited	Regenerative brake not inhibited
(TIU-2) Magnetic Shoe Brake inhibition	Magnetic Shoe Brake inhibited	Magnetic Shoe Brake not inhibited
(TIU-2) Eddy Current Brake for SB inhibition	Eddy Current Brake for SB inhibited	Eddy Current Brake for SB not inhibited
(TIU-2) Eddy Current Brake for EB inhibition	Eddy Current Brake for EB inhibited	Eddy Current Brake for EB not inhibited
(TIU-2) Regenerative Brake status	Regenerative Brake available	Regenerative Brake not available
(TIU-2) Magnetic Shoe Brake status	Magnetic Shoe Brake available	Magnetic Shoe Brake not available
(TIU-2) Eddy Current Brake status	Eddy Current Brake available	Eddy Current Brake not available

Data	Logical 0	Logical 1
(TIU-2) Electro-pneumatic Brake status	Electro-pneumatic Brake available	Electro-pneumatic Brake not available
(TIU-2) Additional Brake status	Additional Brake available	Additional Brake not available
(TIU-4) Pantograph	Lower pantograph	Raise pantograph
(TIU-4) Air Tightness	Air tightness active	Air tightness not active
(TIU-4) Main power switch	Main power switch open	Main power switch close
(TIU-4) Traction Cut-off	Traction cut-off commanded	Traction cut-off not commanded

8.2.4.2.3 The encoding of data with two physical signals is described in Table 12.

Table 12: TIU data with 2 physical signals meaning.

Data	Meaning	MSB Logical Value	LSB Logical Value
(TIU-1) Direction Controller Position	Neutral	0	0
	Forward	0	1
	Backward	1	0
	Not relevant	1	1

8.2.4.2.4 The encoding of data with six physical signals is described in Table 13.

Table 13: TIU data with 6 physical signals meaning.

Data	Meaning	Signal 5 (MSB)	Signal 4	Signal 3	Signal 2	Signal 1	Signal 0 (LSB)
(TIU-2) Brake pressure	0.0 bar	0	0	0	0	0	0
	0.1 bar	0	0	0	0	0	1
	0.2 bar	0	0	0	0	1	0
	0.3 bar	0	0	0	0	1	1
	…	…	…	…	…	…	…
	5.9 bar	1	1	1	0	1	1
	6.0 bar	1	1	1	1	0	0
	Spare	1	1	1	1	0	1
	Spare	1	1	1	1	1	0
	Spare	1	1	1	1	1	1

8.3 Bus driven communication

8.3.1 Introduction

8.3.1.1 For the bus driven communication of the Reference Test Facility with the Test Adaptor, a complete language has been defined. This language is structured in messages and variables.

8.3.1.2 The language uses variables defined in section 7 of Subset-026 (see [2]) and section 4 of Subset-027 (see [3]). In those cases, only the reference shall be provided. For all the other cases, a complete definition of the variable shall be provided within this document.

8.3.1.3 If needed to obtain an integer number of bytes, padding (bit=1) shall be added at the end of the message.

8.3.2 Test messages

8.3.2.1 Every test message begins with a variable to identify it in a unique way. In Table 14, the complete set of test messages, its direction and the interface associated, is provided.

Table 14: List of test messages

Interface	NID_TEST_MESSAGE	Name	Meaning	I/O	Delivery
SIM	1	SIM-1	Start/stop the test	I	Upon Change
	2	SIM-2	Power up/down the nn-board equipment	I	Upon Change
	3	SIM-3	System failure request	I	Upon Change
	4	SIM-4	Ack. message	O	Upon Change
TIU-1	10	TIU-1-I-1	Mode control and train status information	I	Upon Change
	11	TIU-1-O-1	Mode control information (Isolation)	O	Upon Change
TIU-2	20	TIU-2-I-1	Brakes status	I	Upon Change
	21	TIU-2-I-2	Brake pressure	I	Upon Change
	22	TIU-2-O-1	Brakes command	O	Upon Change
	23	TIU-2-O-2	Brakes inhibition	O	Upon Change
TIU-3	30	TIU-3-I-1	Type of train data entry	I	Upon Change
	31	TIU-3-I-2	Train data info	I	Upon Change
TIU-4	40	TIU-4-O-1	Train functions type I	O	Upon Change
TIU-2-4	41	TIU-2-4-O-2	Track conditions with distance	O	Upon Change
TIU-5	50	TIU-5-O-1	Change of traction system	O	Upon Change
	51	TIU-5-O-2	Passenger door control	O	Upon Change
	52	TIU-5-O-3	Change of allowed current consumption	O	Upon Change
ODO	60	ODO-1	Odometry information	I	Cyclically
CMD	70	CMD-1	Cold movement status	I	Upon Change
TDA	80	TDA-1	Type of train data entry	I	Upon Change
	81	TDA-2	Train data info	I	Upon Change
JRI	90	JRI-1	Juridical data information	O	Upon Change

8.3.2.2 **Message number 1: SIM-1**

Description	This message shall be used to start and stop the tests

Transmitted by	LSC		
Content	***Variable***	***Length***	***Comments***
	NID_TEST_MESSAGE	8 bits	
	L_TEST_MESSAGE	12 bits	
	T_TEST	32 bits	
	M_STARTTEST	2 bits	

8.3.2.3 **Message number 2: SIM-2**

Description	This message shall be used to power up and down the on-board equipment		
Transmitted by	LSC		
Content	***Variable***	***Length***	***Comments***
	NID_TEST_MESSAGE	8 bits	
	L_TEST_MESSAGE	12 bits	
	T_TEST	32 bits	
	M_POWERUPEVC	2 bits	

8.3.2.4 **Message number 3: SIM-3**

Description	This message shall be used to create a system failure condition on the on-board equipment		
Transmitted by	LSC		
Content	***Variable***	***Length***	***Comments***
	NID_TEST_MESSAGE	8 bits	
	L_TEST_MESSAGE	12 bits	
	T_TEST	32 bits	
	M_SYSTEMFAILURE	2 bits	

8.3.2.5 **Message number 4: SIM-4**

Description	This message shall be used to acknowledge the reception of SIM messages		
Transmitted by	SIM-A		
Content	***Variable***	***Length***	***Comments***
	NID_TEST_MESSAGE	8 bits	
	L_TEST_MESSAGE	12 bits	
	T_TEST	32 bits	
	NID_TEST_MESSAGE_ACK	8 bits	

8.3.2.6 **Message number 10: TIU-1-I-1**

Description	This message shall be used to transmit the mode control and train status information to the Test Adaptor
Transmitted by	TIS

Content	***Variable***	***Length***	***Comments***
	NID_TEST_MESSAGE	8 bits	
	L_TEST_MESSAGE	12 bits	
	M_SLEEPING_ST	2 bits	
	M_PASSIVESHUNTING_ST	2 bits	
	M_NONLEADING_ST	2 bits	
	M_CAB_ST	3 bits	
	M_DIRECTIONCONTROLLER_ST	3 bits	
	M_TRAININTEGRITY_ST	2 bits	
	M_TRACTION_ST	2 bits	

8.3.2.7 **Message number 11: TIU-1-O-1**

Description	This message shall be used to transmit the Isolation status from the Test Adaptor		
Transmitted by	TIU-A		
Content	***Variable***	***Length***	***Comments***
	NID_TEST_MESSAGE	8 bits	
	L_TEST_MESSAGE	12 bits	
	M_ISOLATION_ST	2 bits	

8.3.2.8 **Message number 20: TIU-2-I-1**

Description	This message shall be used to transmit the brakes status to the Test Adaptor		
Transmitted by	TIS		
Content	***Variable***	***Length***	***Comments***
	NID_TEST_MESSAGE	8 bits	
	L_TEST_MESSAGE	12 bits	
	M_REGENERATIVEBRAKE_ST	2 bits	
	M_EDDYCURRENTBRAKE_ST	2 bits	
	M_MAGNETICSHOEBRAKE_ST	2 bits	
	M_ELECTROPNEUMATICBRAKE_ST	2 bits	
	M_ADDITIONALBRAKE_ST	2 bits	

8.3.2.9 **Message number 21: TIU-2-I-2**

Description	This message shall be used to transmit the brake pressure to the Test Adaptor		
Transmitted by	TIS		
Content	***Variable***	***Length***	***Comments***
	NID_TEST_MESSAGE	8 bits	
	L_TEST_MESSAGE	12 bits	
	P_BRAKEPRESSURE	6 bits	

8.3.2.10 **Message number 22: TIU-2-O-1**

Description	This message shall be used to transmit the brakes command from the Test Adaptor		
Transmitted by	TIU-A		
Content	***Variable***	***Length***	***Comments***
	NID_TEST_MESSAGE	8 bits	
	L_TEST_MESSAGE	12 bits	
	M_SERVICEBRAKE_CM	2 bits	
	M_EMERGENCYBRAKE_CM	2 bits	

8.3.2.11 **Message number 23: TIU-2-O-2**

Description	This message shall be used to transmit the brakes inhibition commands from the Test Adaptor		
Transmitted by	TIU-A		
Content	***Variable***	***Length***	***Comments***
	NID_TEST_MESSAGE	8 bits	
	L_TEST_MESSAGE	12 bits	
	M_REGENERATIVEBRAKE_CM	2 bits	
	M_EDDYCURRENTBRAKE_CM	3 bits	
	M_MAGNETICSHOEBRAKE_CM	2 bits	

8.3.2.12 **Message number 30: TIU-3-I-1**

Description	This message shall be used to transmit the type of train data entry to the Test Adaptor		
Transmitted by	TIS		
Content	***Variable***	***Length***	***Comments***
	NID_TEST_MESSAGE	8 bits	
	L_TEST_MESSAGE	12 bits	
	M_TRAINDATAENTRYTYPE	3 bits	

8.3.2.13 **Message number 31: TIU-3-I-2**

Description	This message shall be used to transmit the train data info to the Test Adaptor		
Transmitted by	TIS		
Content	***Variable***	***Length***	***Comments***
	NID_TEST_MESSAGE	8 bits	
	L_TEST_MESSAGE	12 bits	
	V_MAXTRAIN	7 bits	Defined in Chapter 7 of [2]
	NC_CDTRAIN	4 bits	Defined in Chapter 7 of [2]
	NC_TRAIN	15 bits	Defined in Chapter 7 of [2]
	L_TRAIN	12 bits	Defined in Chapter 7 of [2]
	T_TRACTION_CUT_OFF	12 bits	Defined in Chapter 4 of [3]

	M_BRAKE_POSITION	2 bits	Defined in Chapter 4 of [3]
	M_NOM_ROT_MASS	5 bits	Defined in Chapter 4 of [3]
	M_REGENERATIVEBRAKE	2 bits	Defined in Chapter 4 of [3]
	M_EDDYCURRENTBRAKE	2 bits	Defined in Chapter 4 of [3]
	M_MAGNETICSHOEBRAKE	2 bits	Defined in Chapter 4 of [3]
	M_ELECTROPNEUMATICBRAKE	2 bits	Defined in Chapter 4 of [3]
	M_ADDITIONALBRAKE	2 bits	
	Q_TRACTIONCUTOFFINTERFACE	1 bits	Defined in Chapter 4 of [3]
	Q_SERVICEBRAKEINTERFACE	1 bits	Defined in Chapter 4 of [3]
	Q_SERVICEBRAKEFEEDBACK	1 bits	Defined in Chapter 4 of [3]
	Q_BRAKE_CAPT_TYPE	1 bits	Defined in Chapter 4 of [3]
	M_BRAKE_PERCENTAGE	8 bits	Only if Q_BRAKE_CAPT_TYPE = 0. Defined in Chapter 4 of [3]
	N_BRAKE_CONF	4 bits	Only if Q_BRAKE_CAPT_TYPE = 0. Defined in Chapter 4 of [3]
	M_BRAKE_LAMBDA_CONF(k)	3 bits	Only if Q_BRAKE_CAPT_TYPE = 0. Defined in Chapter 4 of [3]
	T_BRAKE_SERVICE(k)	12 bits	Only if Q_BRAKE_CAPT_TYPE = 0. Defined in Chapter 4 of [3]
	N_BRAKE_CONF	4 bits	Only if Q_BRAKE_CAPT_TYPE = 1 (gamma type), N_BRAKE_CONF and the following variables follow until A_BRAKE_SERVICE_COMP inclusive. Defined in Chapter 4 of [3]
	M_BRAKE_GAMMA_CONF(k)	4 bits	Defined in Chapter 4 of [3]
	T_BRAKE_EMERGENCY(k)	12 bits	Defined in Chapter 4 of [3]
	N_BRAKE_SECTIONS(k)	3 bits	Defined in Chapter 4 of [3]
	V_BRAKE_EMERGENCY_COMP(k, m)	10 bits	Defined in Chapter 4 of [3]
	A_BRAKE_EMERGENCY_COMP(k, m)	8 bits	Defined in Chapter 4 of [3]

	M_KDRY_RST(A_BRAKE_EMERGENCY_COMP(k, m), 0)	5 bits	Defined in Chapter 4 of [3]
	M_KDRY_RST(A_BRAKE_EMERGENCY_COMP(k, m), 1)	5 bits	Defined in Chapter 4 of [3]
	M_KDRY_RST(A_BRAKE_EMERGENCY_COMP(k, m), 2)	5 bits	Defined in Chapter 4 of [3]
	M_KDRY_RST(A_BRAKE_EMERGENCY_COMP(k, m), 3)	5 bits	Defined in Chapter 4 of [3]
	M_KDRY_RST(A_BRAKE_EMERGENCY_COMP(k, m), 4)	5 bits	Defined in Chapter 4 of [3]
	M_KDRY_RST(A_BRAKE_EMERGENCY_COMP(k, m), 5)	5 bits	Defined in Chapter 4 of [3]
	M_KDRY_RST(A_BRAKE_EMERGENCY_COMP(k, m), 6)	5 bits	Defined in Chapter 4 of [3]
	M_KDRY_RST(A_BRAKE_EMERGENCY_COMP(k, m), 7)	5 bits	Defined in Chapter 4 of [3]
	M_KDRY_RST(A_BRAKE_EMERGENCY_COMP(k, m), 8)	5 bits	Defined in Chapter 4 of [3]
	M_KDRY_RST(A_BRAKE_EMERGENCY_COMP(k, m), 9)	5 bits	Defined in Chapter 4 of [3]
	M_KWET_RST(A_BRAKE_EMERGENCY_COMP(k, m))	5 bits	Defined in Chapter 4 of [3]
	T_BRAKE_SERVICE(k)	12 bits	Defined in Chapter 4 of [3]
	N_BRAKE_SECTIONS(k)	3 bits	Defined in Chapter 4 of [3]
	V_BRAKE_SERVICE_COMP(k, m)	10 bits	Defined in Chapter 4 of [3]
	A_BRAKE_SERVICE_COMP(k, m)	8 bits	Defined in Chapter 4 of [3]
	M_LOADINGGAUGE	8 bits	Defined in Chapter 7 of [2]
	N_AXLE	10 bits	Defined in Chapter 7 of [2]
	M_AXLELOADCAT	7 bits	Defined in Chapter 7 of [2]
	N_ITER	5 bits	Defined in Chapter 7 of [2]
	M_VOLTAGE(k)	4 bits	Defined in Chapter 7 of [2]
	NID_CTRACTION(k)	10 bits	Only if M_VOLTAGE(k) ≠ 0. Defined in Chapter 7 of [2]
	N_ITER	5 bits	Defined in Chapter 7 of [2]
	NID_NTC(k)	8 bits	Defined in Chapter 7 of [2]
	M_AIRTIGHT	2 bits	Defined in Chapter 7 of [2]

8.3.2.14 **Message number 40: TIU-4-O-1**

Description	This message shall be used to transmit immediate type I train commands from the Test Adaptor		
Transmitted by	TIU-A		
Content	***Variable***	***Length***	***Comments***
	NID_TEST_MESSAGE	8 bits	
	L_TEST_MESSAGE	12 bits	
	M_PANTOGRAPH_CM	2 bits	
	M_AIRTIGHTNESS_CM	2 bits	
	M_MAINPOWERSWITCH_CM	2 bits	
	M_TRACTIONCUTOFF_CM	2 bits	

8.3.2.15 **Message number 41: TIU-2-4-O-2**

Description	This message shall be used to transmit type I train and brakes inhibition commands with distance from the Test Adaptor		
Transmitted by	TIU-A		
Content	***Variable***	***Length***	***Comments***
	NID_TEST_MESSAGE	8 bits	
	L_TEST_MESSAGE	12 bits	
	Q_TRACKINIT	1 bits	Defined in Chapter 7 of [2]
	D_TEST_TRACKINIT	32 bits	Only if Q_TRACKINIT = 1
	D_TEST_TRACKCOND	32 bits	Only if Q_TRACKINIT = 0, D_TEST_TRACKCOND and the following variables follow
	L_TEST_TRACKCOND	32 bits	
	M_TRACKCOND	4 bits	Defined in Chapter 7 of [2]
	N_ITER	5 bits	Defined in Chapter 7 of [2]
	D_TEST_TRACKCOND(k)	32 bits	
	L_TEST_TRACKCOND(k)	32 bits	
	M_TRACKCOND(k)	4 bits	Defined in Chapter 7 of [2]

8.3.2.16 **Message number 50: TIU-5-O-1**

Description	This message shall be used to transmit the change of traction system from the Test Adaptor		
Transmitted by	TIU-A		
Content	***Variable***	***Length***	***Comments***
	NID_TEST_MESSAGE	8 bits	
	L_TEST_MESSAGE	12 bits	
	D_TEST_TRACTION	32 bits	

	M_VOLTAGE	4 bits	Defined in Chapter 7 of [2]
	NID_CTRACTION	10 bits	Only if M_VOLTAGE ≠ 0. Defined in Chapter 7 of [2]

8.3.2.17 **Message number 51: TIU-5-O-2**

Description	This message shall be used to transmit the passeger door control info from the Test Adaptor		
Transmitted by	TIU-A		
Content	***Variable***	***Length***	***Comments***
	NID_TEST_MESSAGE	8 bits	
	L_TEST_MESSAGE	12 bits	
	Q_TRACKINIT	1 bits	Defined in Chapter 7 of [2]
	D_TEST_TRACKINIT	32 bits	Only if Q_TRACKINIT = 1
	D_TEST_TRACKCOND	32 bits	Only if Q_TRACKINIT = 0, D_TEST_TRACKCOND and the following variables follow
	L_TEST_TRACKCOND	32 bits	
	M_PLATFORM	4 bits	Defined in Chapter 7 of [2]
	Q_PLATFORM	2 bits	Defined in Chapter 7 of [2]
	N_ITER	5 bits	Defined in Chapter 7 of [2]
	D_TEST_TRACKCOND(k)	32 bits	
	L_TEST_TRACKCOND(k)	32 bits	
	M_PLATFORM(k)	4 bits	Defined in Chapter 7 of [2]
	Q_PLATFORM(k)	2 bits	Defined in Chapter 7 of [2]

8.3.2.18 **Message number 52: TIU-5-O-3**

Description	This message shall be used to transmit the change of allowed current consumption from the Test Adaptor		
Transmitted by	TIU-A		
Content	***Variable***	***Length***	***Comments***
	NID_TEST_MESSAGE	8 bits	
	L_TEST_MESSAGE	12 bits	
	D_TEST_CURRENT	32 bits	
	M_CURRENT	10 bits	Defined in Chapter 7 of [2]

8.3.2.19 **Message number 60: ODO-1**

Description	This message shall be used to transmit the odometry information to the Test Adaptor		
Transmitted by	SSS		
Content	***Variable***	***Length***	***Comments***

	NID_TEST_MESSAGE	8 bits	
	L_TEST_MESSAGE	12 bits	
	T_TEST	32 bits	
	Q_TEST_DIST	2 bits	
	D_TEST	32 bits	
	Q_TEST_VEL	2 bits	
	V_TEST	18 bits	
	Q_TEST_ACC	2 bits	
	A_TEST	12 bits	

8.3.2.20 **Message number 70: CMD-1**

Description	This message shall be used to transmit the cold movement status to the Test Adaptor		
Transmitted by	CMS		
Content	***Variable***	***Length***	***Comments***
	NID_TEST_MESSAGE	8 bits	
	L_TEST_MESSAGE	12 bits	
	M_COLDMOVEMENT	2 bits	

8.3.2.21 **Message number 80: TDA-1**

Description	This message shall be used to transmit the type of train data entry to the Test Adaptor		
Transmitted by	TDS		
Content	***Variable***	***Length***	***Comments***
	NID_TEST_MESSAGE	8 bits	
	L_TEST_MESSAGE	12 bits	
	M_TRAINDATAENTRYTYPE	3 bits	

8.3.2.22 **Message number 81: TDA-2**

Description	This message shall be used to transmit the train data info to the Test Adaptor		
Transmitted by	TDS		
Content	***Variable***	***Length***	***Comments***
	NID_TEST_MESSAGE	8 bits	
	L_TEST_MESSAGE	12 bits	
	V_MAXTRAIN	7 bits	Defined in Chapter 7 of [2]
	NC_CDTRAIN	4 bits	Defined in Chapter 7 of [2]
	NC_TRAIN	15 bits	Defined in Chapter 7 of [2]
	L_TRAIN	12 bits	Defined in Chapter 7 of [2]
	T_TRACTION_CUT_OFF	12 bits	Defined in Chapter 4 of [3]
	M_BRAKE_POSITION	2 bits	Defined in Chapter 4 of [3]
	M_NOM_ROT_MASS	5 bits	Defined in Chapter 4 of [3]

	M_REGENERATIVEBRAKE	2 bits	Defined in Chapter 4 of [3]
	M_EDDYCURRENTBRAKE	2 bits	Defined in Chapter 4 of [3]
	M_MAGNETICSHOEBRAKE	2 bits	Defined in Chapter 4 of [3]
	M_ELECTROPNEUMATICBRAKE	2 bits	Defined in Chapter 4 of [3]
	M_ADDITIONALBRAKE	2 bits	
	Q_TRACTIONCUTOFFINTERFACE	1 bits	Defined in Chapter 4 of [3]
	Q_SERVICEBRAKEINTERFACE	1 bits	Defined in Chapter 4 of [3]
	Q_SERVICEBRAKEFEEDBACK	1 bits	Defined in Chapter 4 of [3]
	Q_BRAKE_CAPT_TYPE	1 bits	Defined in Chapter 4 of [3]
	M_BRAKE_PERCENTAGE	8 bits	Only if Q_BRAKE_CAPT_TYPE = 0. Defined in Chapter 4 of [3]
	N_BRAKE_CONF	4 bits	Only if Q_BRAKE_CAPT_TYPE = 0. Defined in Chapter 4 of [3]
	M_BRAKE_LAMBDA_CONF(k)	3 bits	Only if Q_BRAKE_CAPT_TYPE = 0. Defined in Chapter 4 of [3]
	T_BRAKE_SERVICE(k)	12 bits	Only if Q_BRAKE_CAPT_TYPE = 0. Defined in Chapter 4 of [3]
	N_BRAKE_CONF	4 bits	Only if Q_BRAKE_CAPT_TYPE = 1 (gamma type), N_BRAKE_CONF and the following variables follow until A_BRAKE_SERVICE_COMP inclusive. Defined in Chapter 4 of [3]
	M_BRAKE_GAMMA_CONF(k)	4 bits	Defined in Chapter 4 of [3]
	T_BRAKE_EMERGENCY(k)	12 bits	Defined in Chapter 4 of [3]
	N_BRAKE_SECTIONS(k)	3 bits	Defined in Chapter 4 of [3]
	V_BRAKE_EMERGENCY_COMP(k, m)	10 bits	Defined in Chapter 4 of [3]
	A_BRAKE_EMERGENCY_COMP(k, m)	8 bits	Defined in Chapter 4 of [3]
	M_KDRY_RST(A_BRAKE_EMERGENCY_COMP(k, m), 0)	5 bits	Defined in Chapter 4 of [3]

	M_KDRY_RST(A_BRAKE_EMERGENCY_COMP(k, m), 1)	5 bits	Defined in Chapter 4 of [3]
	M_KDRY_RST(A_BRAKE_EMERGENCY_COMP(k, m), 2)	5 bits	Defined in Chapter 4 of [3]
	M_KDRY_RST(A_BRAKE_EMERGENCY_COMP(k, m), 3)	5 bits	Defined in Chapter 4 of [3]
	M_KDRY_RST(A_BRAKE_EMERGENCY_COMP(k, m), 4)	5 bits	Defined in Chapter 4 of [3]
	M_KDRY_RST(A_BRAKE_EMERGENCY_COMP(k, m), 5)	5 bits	Defined in Chapter 4 of [3]
	M_KDRY_RST(A_BRAKE_EMERGENCY_COMP(k, m), 6)	5 bits	Defined in Chapter 4 of [3]
	M_KDRY_RST(A_BRAKE_EMERGENCY_COMP(k, m), 7)	5 bits	Defined in Chapter 4 of [3]
	M_KDRY_RST(A_BRAKE_EMERGENCY_COMP(k, m), 8)	5 bits	Defined in Chapter 4 of [3]
	M_KDRY_RST(A_BRAKE_EMERGENCY_COMP(k, m), 9)	5 bits	Defined in Chapter 4 of [3]
	M_KWET_RST(A_BRAKE_EMERGENCY_COMP(k, m))	5 bits	Defined in Chapter 4 of [3]
	T_BRAKE_SERVICE(k)	12 bits	Defined in Chapter 4 of [3]
	N_BRAKE_SECTIONS(k)	3 bits	Defined in Chapter 4 of [3]
	V_BRAKE_SERVICE_COMP(k, m)	10 bits	Defined in Chapter 4 of [3]
	A_BRAKE_SERVICE_COMP(k, m)	8 bits	Defined in Chapter 4 of [3]
	M_LOADINGGAUGE	8 bits	Defined in Chapter 7 of [2]
	N_AXLE	10 bits	Defined in Chapter 7 of [2]
	M_AXLELOADCAT	7 bits	Defined in Chapter 7 of [2]
	N_ITER	5 bits	Defined in Chapter 7 of [2]
	M_VOLTAGE(k)	4 bits	Defined in Chapter 7 of [2]
	NID_CTRACTION(k)	10 bits	Only if M_VOLTAGE(k) ≠ 0. Defined in Chapter 7 of [2]
	N_ITER	5 bits	Defined in Chapter 7 of [2]
	NID_NTC(k)	8 bits	Defined in Chapter 7 of [2]
	M_AIRTIGHT	2 bits	Defined in Chapter 7 of [2]

8.3.2.23 **Message number 90: JRI-1**

Description	This message shall be used to transmit the juridical data information from the Test Adaptor		
Transmitted by	JRI-A		
Content	***Variable***	***Length***	***Comments***
	NID_TEST_MESSAGE	8 bits	
	L_TEST_MESSAGE	12 bits	
	<JRU MESSAGE>	8 bits	Defined in Chapter 4 of [3]

8.3.3 Test variables

8.3.3.1 A_TEST

Name	Simulated train absolute acceleration		
Description	Instantaneous value of the simulated train acceleration		
Length of variable	***Minimum Value***	***Maximum Value***	***Resolution/formula***
12 bits	0 mm/s²	4094 mm/s²	1 mm/s²
Special/Reserved Values	4095	Unknown	

8.3.3.2 D_TEST

Name	Absolute test distance sign		
Description	Absolute distance managed by the laboratory for every simulation		
Length of variable	***Minimum Value***	***Maximum Value***	***Resolution/formula***
32 bits	0 mm	42949672940 mm	10 mm
Special/Reserved Values	4294967295	Unknown	

8.3.3.3 D_TEST_CURRENT

Name	Test distance to change of allowed current consumption		
Description			
Length of variable	***Minimum Value***	***Maximum Value***	***Resolution/formula***
32 bits	0 mm	42949672940 mm	10 mm
Special/Reserved Values	4294967295	Now	

8.3.3.4 D_TEST_TRACKCOND

Name	Track condition test distance		
Description	The test distance to where the track conditions change		
Length of variable	***Minimum Value***	***Maximum Value***	***Resolution/formula***
32 bits	0 mm	42949672940 mm	10 mm
Special/Reserved Values	4294967295	Now	

8.3.3.5 D_TEST_TRACKINIT

Name	Test distance to start an empty profile		
Description	Test distance to where initial states of the related track condition shall be resumed		
Length of variable	***Minimum Value***	***Maximum Value***	***Resolution/formula***
32 bits	0 mm	42949672940 mm	10 mm
Special/Reserved Values	4294967295	Now	

8.3.3.6 D_TEST_TRACTION

Name	Test distance to change of traction		
Description			
Length of variable	***Minimum Value***	***Maximum Value***	***Resolution/formula***
32 bits	0 mm	42949672940 mm	10 mm
Special/Reserved Values	4294967295	Now	

8.3.3.7 L_TEST_MESSAGE

Name	Message length in bytes		
Description	Length of the message in bytes, including the needed padding bits rounding up to the nearest greater integer.		
Length of variable	***Minimum Value***	***Maximum Value***	***Resolution/formula***
12 bits	0	4095	1 Byte

8.3.3.8 L_TEST_TRACKCOND

Name	Length for which the defined track condition is valid		
Description			
Length of variable	***Minimum Value***	***Maximum Value***	***Resolution/formula***
32 bits	0 mm	42949672940 mm	10 mm
Special/Reserved Values	4294967295	Infinite length	

8.3.3.9 M_ADDITIONALBRAKE

Name	Additional brake interface		
Description	Describes the interface with the additional brake independent of the wheel/rail adhesion and whether it affects the braking curve calculation		
Length of variable	***Minimum Value***	***Maximum Value***	***Resolution/formula***
2 bits	na	na	na
Special/Reserved Values	00	No interface	
	01	Interface exists and affects EB under reduced adhesion conditions	

	10	Spare
	11	Spare

8.3.3.10 M_ADDITIONALBRAKE_ST

Name	Additional brake status		
Description	Status of the additional brake signal (TIU-2)		
Length of variable	***Minimum Value***	***Maximum Value***	***Resolution/formula***
2 bits	na	na	na
Special/Reserved Values	00	Information not available	
	01	Additional brake is active	
	10	Additional brake is not active	
	11	Fail state	

8.3.3.11 M_AIRTIGHTNESS_CM

Name	Air tightness command		
Description	Indicates the actions on the air-tightness system		
Length of variable	***Minimum Value***	***Maximum Value***	***Resolution/formula***
2 bits	na	na	na
Special/Reserved Values	00	Information not available	
	01	Tunnel condition active	
	10	Tunnel condition not active	
	11	Fail state	

8.3.3.12 M_CAB_ST

Name	Cab (Desk) activation status		
Description	Status of the cab (desk) activation signal (TIU-1)		
Length of variable	***Minimum Value***	***Maximum Value***	***Resolution/formula***
3 bits	na	na	na
Special/Reserved Values	000	Information not available	
	001	Both desks are closed	
	010	Desk A is open	
	011	Desk B is open	
	100	Both desks are open	
	101	Spare	
	110	Spare	
	111	Fail state	

8.3.3.13 M_COLDMOVEMENT

Name	Cold Movement Status

Description	Indicates the status provided by the Cold Movement Detector		
Length of variable	***Minimum Value***	***Maximum Value***	***Resolution/formula***
2 bits	na	na	na
Special/Reserved Values	00	Information not available	
	01	Train has moved	
	10	Train has not moved	
	11	Fail state	

8.3.3.14 **M_DIRECTIONCONTROLLER_ST**

Name	Direction controller status		
Description	Status of the direction controller signal (TIU-1)		
Length of variable	***Minimum Value***	***Maximum Value***	***Resolution/formula***
3 bits	na	na	na
Special/Reserved Values	000	Information not available	
	001	Direction controller in neutral	
	010	Direction controller in forward	
	011	Direction controller in backward	
	100	Spare	
	101	Spare	
	110	Spare	
	111	Fail state	

8.3.3.15 **M_EDDYCURRENTBRAKE_CM**

Name	Eddy current brake inhibition		
Description	Status of the eddy current brake inhibition signal (TIU-2)		
Length of variable	***Minimum Value***	***Maximum Value***	***Resolution/formula***
3 bits	na	na	na
Special/Reserved Values	000	Information not available	
	001	Inhibit eddy current brake for service brake	
	010	Inhibit eddy current brake for emergency brake	
	011	Inhibit eddy current brake for both service and emergency brake	
	100	Do not inhibit eddy current brake for service brake	
	101	Do not inhibit eddy current brake for emergency brake	
	110	Do not inhibit eddy current brake for both service and emergency brake	
	111	Fail state	

8.3.3.16 **M_EDDYCURRENTBRAKE_ST**

Name	Eddy Current brake status		
Description	Status of the eddy current brake signal (TIU-2)		
Length of variable	***Minimum Value***	***Maximum Value***	***Resolution/formula***
2 bits	na	na	na
Special/Reserved Values	00	Information not available	
	01	Eddy current brake is active	
	10	Eddy current brake is not active	
	11	Fail state	

8.3.3.17 **M_ELECTROPNEUMATICBRAKE_ST**

Name	Electropneumatic brake status		
Description	Status of the electro pneumatic brake signal (TIU-2)		
Length of variable	***Minimum Value***	***Maximum Value***	***Resolution/formula***
2 bits	na	na	na
Special/Reserved Values	00	Information not available	
	01	Electro pneumatic brake is active	
	10	Electro pneumatic brake is not active	
	11	Fail state	

8.3.3.18 **M_EMERGENCYBRAKE_CM**

Name	Emergency Brake signal command		
Description	Status of the emergency brake command signal (TIU-2)		
Length of variable	***Minimum Value***	***Maximum Value***	***Resolution/formula***
2 bits	na	na	na
Special/Reserved Values	00	Information not available	
	01	Apply emergency brake	
	10	Release emergency brake	
	11	Fail state	

8.3.3.19 **M_ISOLATION_ST**

Name	Isolation signal status		
Description	Status of the isolation signal (TIU-1)		
Length of variable	***Minimum Value***	***Maximum Value***	***Resolution/formula***
2 bits	na	na	na
Special/Reserved Values	00	Information not available	
	01	On-board equipment is isolated	
	10	On-board equipment is not isolated	
	11	Fail state	

8.3.3.20 **M_MAGNETICSHOEBRAKE_CM**

Name	Magnetic shoe brake inhibition		
Description	Status of the magnetic shoe brake inhibition signal (TIU-2)		
Length of variable	***Minimum Value***	***Maximum Value***	***Resolution/formula***
2 bits	na	na	na
Special/Reserved Values	00	Information not available	
	01	Inhibit magnetic shoe brake	
	10	Do not inhibit magnetic shoe brake	
	11	Fail state	

8.3.3.21 **M_MAGNETICSHOEBRAKE_ST**

Name	Magnetic Shoe brake status		
Description	Status of the magnetic shoe brake signal (TIU-2)		
Length of variable	***Minimum Value***	***Maximum Value***	***Resolution/formula***
2 bits	na	na	na
Special/Reserved Values	00	Information not available	
	01	Magnetic shoe brake is active	
	10	Magnetic shoe brake is not active	
	11	Fail state	

8.3.3.22 **M_MAINPOWERSWITCH_CM**

Name	Main power switch command		
Description	Indicates the actions on the main power switch		
Length of variable	***Minimum Value***	***Maximum Value***	***Resolution/formula***
2 bits	na	na	na
Special/Reserved Values	00	Information not available	
	01	Open main power switch	
	10	Close main power switch	
	11	Fail state	

8.3.3.23 **M_NONLEADING_ST**

Name	Non Leading Information		
Description	Status of the non leading signal (TIU-1)		
Length of variable	***Minimum Value***	***Maximum Value***	***Resolution/formula***
2 bits	na	na	na
Special/Reserved Values	00	Information not available	
	01	Non Leading permitted	
	10	Non Leading not permitted	
	11	Fail state	

8.3.3.24 M_PANTOGRAPH_CM

Name	Pantograph command		
Description	Indicates the actions on the pantograph		
Length of variable	***Minimum Value***	***Maximum Value***	***Resolution/formula***
2 bits	na	na	na
Special/Reserved Values	00	Information not available	
	01	Lower pantograph	
	10	Raise pantograph	
	11	Fail state	

8.3.3.25 M_PASSIVESHUNTING_ST

Name	Passive Shunting signal status		
Description	Status of the passive shunting signal (TIU-1)		
Length of variable	***Minimum Value***	***Maximum Value***	***Resolution/formula***
2 bits	na	na	na
Special/Reserved Values	00	Information not available	
	01	Passive Shunting permitted	
	10	Passive Shunting not permitted	
	11	Fail state	

8.3.3.26 M_POWERUPEVC

Name	Variable to power up/down the ETCS on-board unit		
Description			
Length of variable	***Minimum Value***	***Maximum Value***	***Resolution/formula***
2 bits	na	na	na
Special/Reserved Values	00	Information not available	
	01	Power up the ETCS on-board unit	
	10	Power down the ETCS on-board unit	
	11	Fail state	

8.3.3.27 M_REGENERATIVEBRAKE_CM

Name	Regenerative brake inhibition		
Description	Status of the regenerative brake inhibition signal (TIU-2)		
Length of variable	***Minimum Value***	***Maximum Value***	***Resolution/formula***
2 bits	na	na	na
Special/Reserved Values	00	Information not available	
	01	Inhibit regenerative brake	
	10	Do not inhibit regenerative brake	

	11	Fail state

8.3.3.28 **M_REGENERATIVEBRAKE_ST**

Name	Regenerative brake status		
Description	Status of the regenerative brake signal (TIU-2)		
Length of variable	***Minimum Value***	***Maximum Value***	***Resolution/formula***
2 bits	na	na	na
Special/Reserved Values	00	Information not available	
	01	Regenerative brake is active	
	10	Regenerative brake is not active	
	11	Fail state	

8.3.3.29 **M_SERVICEBRAKE_CM**

Name	Service Brake signal command		
Description	Status of the service brake command signal (TIU-2)		
Length of variable	***Minimum Value***	***Maximum Value***	***Resolution/formula***
2 bits	na	na	na
Special/Reserved Values	00	Information not available	
	01	Apply service brake	
	10	Release service brake	
	11	Fail state	

8.3.3.30 **M_SLEEPING_ST**

Name	Sleeping signal status		
Description	Status of the sleeping signal (TIU-1)		
Length of variable	***Minimum Value***	***Maximum Value***	***Resolution/formula***
2 bits	na	na	na
Special/Reserved Values	00	Information not available	
	01	Signal active	
	10	Signal not active	
	11	Fail state	

8.3.3.31 **M_STARTTEST**

Name	Variable to start/stop the test		
Description			
Length of variable	***Minimum Value***	***Maximum Value***	***Resolution/formula***
2 bits	na	na	na
Special/Reserved Values	00	Information not available	
	01	Start Test	

	10	Stop Test
	11	Fail state

8.3.3.32 M_SYSTEMFAILURE

Name	Variable to enable/disable a system failure situation in the ETCS on-board unit		
Description			
Length of variable	***Minimum Value***	***Maximum Value***	***Resolution/formula***
2 bits	na	na	na
Special/Reserved Values	00	Information not available	
	01	Enable a SF state in the ETCS on-board unit	
	10	Disable a SF state in the ETCS on-board unit	
	11	Fail state	

8.3.3.33 M_TRACTION_ST

Name	Traction status information		
Description	Status of the train traction signal (TIU-1)		
Length of variable	***Minimum Value***	***Maximum Value***	***Resolution/formula***
2 bits	na	na	na
Special/Reserved Values	00	Information not available	
	01	Traction on	
	10	Traction off	
	11	Fail state	

8.3.3.34 M_TRACTIONCUTOFF_CM

Name	Traction cut-off command		
Description	Indicates the actions on the traction cut-off system		
Length of variable	***Minimum Value***	***Maximum Value***	***Resolution/formula***
2 bits	na	na	na
Special/Reserved Values	00	Information not available	
	01	Apply traction cut-off	
	10	Release traction cut-off	
	11	Fail state	

8.3.3.35 M_TRAINDATAENTRYTYPE

Name	Train data entry type		
Description	Indicates the type of train data entry (TIU-3)		
Length of variable	***Minimum Value***	***Maximum Value***	***Resolution/formula***
3 bits	na	na	na

Special/Reserved Values	000	Information not available
	001	Fixed train data entry type
	010	Flexible train data entry type
	011	Switchable train data entry type
	100	Spare
	101	Spare
	110	Spare
	111	Fail state

8.3.3.36 **M_TRAININTEGRITY_ST**

Name	Train Integrity Information		
Description	Status of the train integrity signal (TIU-1)		
Length of variable	***Minimum Value***	***Maximum Value***	***Resolution/formula***
2 bits	na	na	na
Special/Reserved Values	00	Information not available	
	01	Train is not integer	
	10	Train is integer	
	11	Fail state	

8.3.3.37 **NID_TEST_MESSAGE**

Name	Test message identifier		
Description	Test message identifier. For the defined values of NID_TEST_MESSAGE, please see appendix A.		
Length of variable	***Minimum Value***	***Maximum Value***	***Resolution/formula***
8 bits	0	255	Numbers
Special/Reserved Values	0	Not Used	

8.3.3.38 **NID_TEST_MESSAGE_ACK**

Name	Identifier of the test message to be acknowledged		
Description	Only valid for simulation management test messages		
Length of variable	***Minimum Value***	***Maximum Value***	***Resolution/formula***
8 bits	1	3	Numbers
Special/Reserved Values	0	Not Used	
	4-255	Not Used	

8.3.3.39 **P_BRAKEPRESSURE**

Name	Brake pressure value
Description	Indicates the value of the brake pressure (TIU-2)

Length of variable	***Minimum Value***	***Maximum Value***	***Resolution/formula***
6 bits	0 bar	6 bar	0.1 bar
Special/Reserved Values	61	Spare	
	62	Information not available	
	63	Fail state	

8.3.3.40 **Q_TEST_ACC**

Name	Acceleration sign		
Description	Indicates whether the train is accelerating or braking		
Length of variable	***Minimum Value***	***Maximum Value***	***Resolution/formula***
2 bits	na	na	na
Special/Reserved Values	00	Information not available	
	01	Train is braking	
	10	Train is accelerating	
	11	Fail state	

8.3.3.41 **Q_TEST_DIST**

Name	Absolute test distance sign		
Description	Indicates the sign of the distance overrun from the beggining of the test		
Length of variable	***Minimum Value***	***Maximum Value***	***Resolution/formula***
2 bits	na	na	na
Special/Reserved Values	00	Information not available	
	01	Positive sign	
	10	Negative sign	
	11	Fail state	

8.3.3.42 **Q_TEST_VEL**

Name	Test speed sign		
Description	Indicates the sense of movement, considering which cabine of the train is being tested		
Length of variable	***Minimum Value***	***Maximum Value***	***Resolution/formula***
2 bits	na	na	na
Special/Reserved Values	00	Information not available	
	01	Forward movement	
	10	Backwards movement	
	11	Fail state	

8.3.3.43 **T_TEST**

Name	Laboratory clock

Description	Time of the laboratory clock		
Length of variable	***Minimum Value***	***Maximum Value***	***Resolution/formula***
32 bits	0 ms	42949672940 ms	10 ms
Special/Reserved Values	4294967295	Unknown	

8.3.3.44 **V_TEST**

Name	Simulated train speed		
Description	Instantaneous value of the simulated train speed		
Length of variable	***Minimum Value***	***Maximum Value***	***Resolution/formula***
18 bits	0 mm/s	262142 mm/s	1 mm/s
Special/Reserved Values	262143	Unknown	

8.3.4 Physical layer

8.3.4.1 For the bus driven communication, two main physical interfaces are recommended: Ethernet or Serial.

8.3.4.2 **Ethernet**

8.3.4.2.1 Ethernet interface will use TCP/IP protocols for the communication between the Reference Test Laboratory and the Test Adaptor.

8.3.4.2.2 The Test Adaptor shall work as the server, while the Reference test facility module shall works as clients.

8.3.4.2.3 Every interface in Table 6 shall be managed with a different TCP/IP socket.

8.3.4.3 **Serial**

8.3.4.3.1 Serial interface shall be compliant to RS-422/V.11 specifications. Only TX, RX and GND lines shall be employed. The baud rate for transmission shall be 1 Mb/s.

8.3.4.3.2 Messages shall be encapsulated in order to ensure completeness and validity of data. Encapsulation is described in Table 15.

Table 15: Test message encapsulation for serial transmission.

Size	Description	Range
1 byte	Header of the frame	STX (0x02)
N bytes	Test messages (see 8.3.2): the text data are included in the frame with no modification. The value of each byte of a binary stream is converted in 2 ASCII characters (“00” to “FF”).	String
2 bytes	Checksum: it is calculated only on the N bytes (STX is excluded). The calculation consists on a XOR operation with each ASCII character: The checksum is initialized at zero.	“00” to “FF”
1 byte	Footer of the frame	ETX (0x03)

8.3.4.3.3 It shall be possible to share the same physical link by several interfaces of Table 6. In any case, once the ERTMS/ETCS on-board equipment is connected and ready for testing, the test facility shall prove, following its internal procedures, that the performance requirements included in this document are fulfilled.

9. RCS DETAILS

9.1.1.1 For a correct encryption of the euroradio communication, every ETCS on-board equipment shall be configured to work with the following RBCs.

Table 16: RBC parameters for testing

RBC #	NID_C	NID_RBC	ETCS_ID (dec)	ETCS_ID (hex)
1	352	1515	5768683	0x5805EB
2	352	1616	5768784	0x580650
3	64	1515	1050091	0x1005EB
4	64	1616	1050192	0x100650

9.1.1.1.1 The RBC ETCS identifiers are calculated as a concatenation of variables NID_C and NID_RBC

9.1.1.2 The Kmac to be used with RBCs (1) and (3) (in hexadecimal) is the following one:

6D 16 79 98 98 6B 3D 54

FD AD 4A B5 07 0E C2 3B

6D 16 79 98 98 6B 3D 54

9.1.1.3 The Kmac to be used with RBCs (2) and (4) (in hexadecimal) is the following one:

01 02 04 07 08 0B 0D 0E
10 13 15 16 19 1A 1C 1F
20 23 25 26 29 2A 2C 2F

10. BCS DETAILS

10.1.1.1 In order to calibrate correctly the laboratory devices which shall transmit the Eurobalise signal to the train antenna, it is recommended:

10.1.1.1.1 Use of reduced size reference loop as defined in Annex H2 in Subset-085 (see [13]).

10.1.1.1.2 Use of Current Sense Balun (CS Balun) as defined in Annex H5.4 in Subset-085 (see [13]).

10.1.1.1.3 Use of High Power Low Pass Filter (HPLP Filter) as defined in Annex F2 in Subset-085 (see [13]).

10.1.1.2 The reduced size reference loop shall be installed in longitudinal position with respect to the train antenna (see [13]).

10.1.1.3 The distance between train antenna and Reference Loop shall be 220mm.

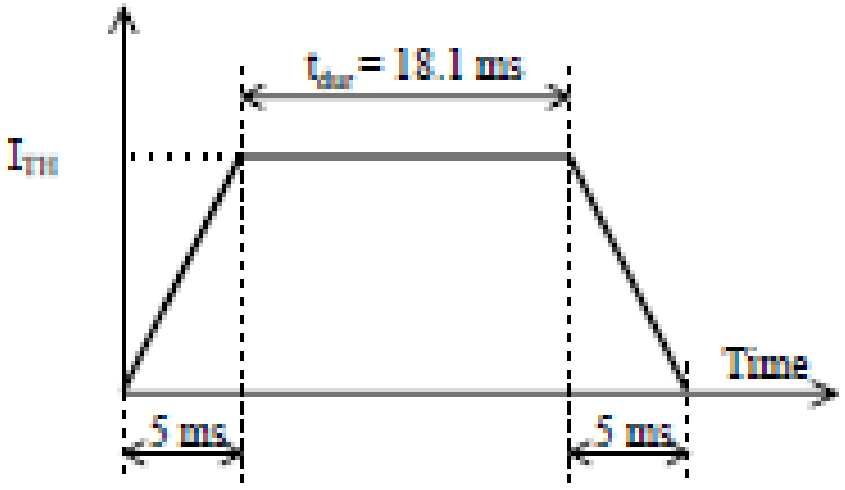
10.1.1.4 The measured power in the current sense balun equivalent to Current beween Iu2 and Iu3 (defined in the input/output characteristics tests) shall be around

Iu2 = 59mA (equiv) -11.10 dBm
Iu3 = 186 mA (equiv) -1.12 dBm

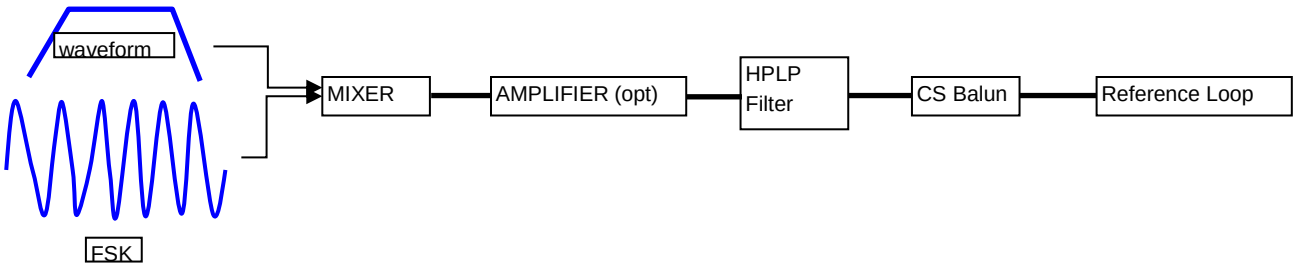
10.1.1.5 The equivalence in power is calculated taken into account the measured parameters of the current sense balun, summarized below

Iu2 current (mA)	59
Reference Loop B factor at 4.2MHz	0,94
Impedance of CS Balun	50,044
CS Balun Transfer Ratio	3,94E-04
Calculated Plc (dBm)	-11,10

10.1.1.6 For the balise shape the following form is proposed. It was extracted from chapter 5.2.3.1 of Subset-085 (see [13]). The times correspond to speed = 100Km/h.:



10.1.1.7 The final test configuration shall comply with the following schema



10.1.1.8 After measurement and calibration, the Current Sense Balun can be replaced by a Reference Loop Balun (defined in Annex H5.3 of Subset-085 [13]) for normal operation.