

## ERTMS/ETCS

### Performance Requirements for Interoperability

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### 3. INTRODUCTION

- 3.1.1.1 This document contains an analysis of the required technical performances of ERTMS/ETCS equipment that are relevant for interoperability.
- 3.1.1.2 This means that only characteristics meeting the two following criteria are taken into account:
- a) they must be linked to events that happen on interoperable equipment interfaces. This generally makes it possible to measure the corresponding technical performance at such interfaces. (Exceptions are clock accuracy, age of position measurement for position reporting and odometric performances, for which the supplier will indicate suitable procedures for demonstration that are in any case outside the scope of this document);
  - b) they must be relevant for the acceptability of a train on a given line.
- 3.1.1.3 According to SRS, (SUBSET-026) chapter 2, the interoperable interfaces are:
- a) the DMI (ERA\_ERTMS\_015560);
  - b) the train interface (SUBSET-034);
  - c) intentionally deleted;
  - d) the Eurobalise airgap (SUBSET-036);
  - e) the Euroloop airgap (SUBSET-044);
  - f) the FRMCS on-board equipment – ETCS on-board interface (FRMCS FIS-7970, FRMCS FFFIS-7950, SUBSET-037);
  - g) the FRMCS trackside – RBC interface (FRMCS FIS-7970, FRMCS FFFIS-7950, SUBSET-037)
  - h) the GSM-R Mobile – ETCS on-board interface (A11T6001, SUBSET-037);
  - i) the GSM-R fixed network – RBC interface (SUBSET-037);
  - j) the RBC-RBC interface (SUBSET-039, SUBSET-098).
- 3.1.1.4 Procedures for the demonstration of achievement of performances are not in the scope of this document.
- 3.1.1.5 RAMS requirements are not in the scope in this document.
- 3.1.1.6 Only levels 0, 1 and 2 are considered in this document.
- 3.1.1.7 Intentionally deleted.



- 3.1.1.8 Performance requirements in level NTC will be according to the corresponding “national” system and are not considered here (in case the ERTMS/ETCS on-board equipment is interfaced to the National System through an STM, refer to SUBSET-059 “Performance Requirements for STMs”).
- 3.1.1.9 Chapter 4 contains an example to clarify the criteria used to identify performance requirements relevant for interoperability.
- 3.1.1.10 Chapter 5 contains the list of performance requirements and their values.

## 4. CLARIFICATION OF CRITERIA

- 4.1.1.1 This chapter contains considerations to make clear which criteria were followed to identify technical performance requirements of ERTMS equipment which are relevant for interoperability.
- 4.1.1.2 The starting point is, obviously, the fact that ERTMS must allow the achievement of operational performances of the railway transportation system, where it is installed.
- 4.1.1.3 In any case, such operational performances do not depend only on ERTMS: their achievement is in general related to various factors, e.g.:
- a) Physical characteristics of the trackside, such as gradients
  - b) Design of the trackside signalling, such as block length, spacing of balise groups, etc.
  - c) Quality of installation, such as accuracy of positioning of balise groups
  - d) Train characteristics, such as length, braking capability, etc.
  - e) Technical performances of non-ERTMS equipment, such as response time of train detection equipment, delay of messages in FRMCS/GSM-R network, etc.
  - f) Accuracy of information used by ERTMS equipment, such as resolution of variables
  - g) Technical performances of the ERTMS equipment, such as response times, accuracy of location functions, etc.
- 4.1.1.4 Considering, for instance, the accuracy of supervision of the EOA, it is affected by:
- a) Knowledge of the train position (with respect to the LRBG/ORBG), depending on the accuracy of train position ensured by the ERTMS on-board equipment and on the spacing of balise groups (design of trackside signalling)
  - b) Knowledge of the distance to the EOA, depending on resolution and accuracy of distances given in the MA messages and on accuracy of balise installation
  - c) Knowledge of line gradients, depending on resolution and accuracy of information in profile messages
  - d) Accuracy of the train speed measured by the ERTMS on-board equipment
  - e) Accuracy of braking model and parameters, (i.e., accuracy of the modelling of the train)
- 4.1.1.5 Only technical performance requirements related to characteristics of ERTMS equipment and relevant for interoperability are considered in this document: for them limit values, according to the state-of-the-art of technological solutions, are given.





- 4.1.1.6 Other factors, related to physical characteristics of the line or the train, design of trackside signalling, accuracy of installation or modelling of the train, are out of the scope.

## 5. VALUES FOR TECHNICAL PERFORMANCES

### 5.1 General considerations

5.1.1.1 The following tables summarise the possible values for technical performance requirements of ERTMS on-board equipment. For each of them feasibility limits are indicated.

5.1.1.2 Technical performance requirements implying response times are defined according to a start event and a stop event which can be observed on interoperable interfaces.

5.1.1.3 If the start event defining the performance is the receiving of a message by the on-board ERTMS equipment, the value is valid if the actions due to previously received messages are completed (e.g., emergency brake order completely issued, communication session established, indication to driver updated).

5.1.1.4 If the end event defining the performance is the sending of a message by the on-board ERTMS equipment, the value is valid if the sending of previous messages is completed.

5.1.1.5 Note: according to SUBSET-026, in case of balise transmission “telegram” is the information sent by one balise and “message” is the whole set of “telegrams” sent by the balises of a group.

### 5.2 Response Times

5.2.1.1 Delay between receiving of a balise message and applying the emergency brake

Description	<b>delay between receiving of a balise message and applying the emergency brake</b>
Start Event	The reference mark of the on-board antenna leaving the “side lobe zone” of the last balise in the group (1.3 m from the reference mark of the balise)
Stop Event	Beginning of issuing of the braking order on the TIU-train interface
Value	< 1 sec
Notes	It is assumed that the activation of the emergency brake is required by the message contained in the balise group.

5.2.1.2 Delay between receiving of a balise message and initiating a communication session establishment

<b>Description</b>	<b>delay between receiving of a balise message and initiating a communication session establishment</b>
Start Event	The reference mark of the on-board antenna leaving the “side lobe zone” of the last balise in the group (1.3 m from the reference mark of the balise)
Stop Event	Beginning of sending of the connection request to the FRMCS on-board equipment/GSM-R mobile - ETCS on-board interface
Value	< 1.5 sec
Notes	It is assumed that the establishment of the communication session is required by the message contained in the balise group.

5.2.1.3 Delay between receiving of a balise message and reporting the resulting change of status on-board (e.g., update of EOA, level transition, mode change)

<b>Description</b>	<b>delay between receiving of a balise message and reporting the resulting change of status on-board</b>
Start Event	The reference mark of the on-board antenna leaving the “side lobe zone” of the last balise in the group (1.3 m from the reference mark of the balise)
Stop Event	Indication to the driver
Value	< 1.5 sec
Notes	It is assumed that the change of status is required by the message contained in the balise group.  The value indicated in this case includes additional delay for the display of the information.

5.2.1.4 Delay between receiving of a MA via radio (both from RBC and from radio in-fill) and the update of EOA/LOA on-board

<b>Description</b>	<b>delay between receiving of a MA via radio (both from RBC and from radio in-fill) and the update of EOA/LOA on-board</b>
Start Event	Reception of the complete MA message at the FRMCS on-board equipment/GSM-R mobile - ETCS on-board interface
Stop Event	Indication to the driver
Value	< 1.5 sec
Notes	It is assumed that the update of the EOA/LOA is required by the message received.  The value indicated in this case includes additional delay for the display of the information.

5.2.1.5 Delay between receiving of a MA from Euroloop and the update of EOA/LOA on-board



<b>Description</b>	<b>delay between receiving of a MA from Euroloop and the update of EOA/LOA on-board</b>
Start Event	A) On-board Euroloop receiver is synchronised, and B) A complete MA message has been received at the Euroloop air gap interface
Stop Event	Indication to the driver
Value	< 1.5 sec
Notes	It is assumed that the update of the EOA/LOA is required by the message received. The value indicated in this case includes additional delay for the display of the information.

<b>Description</b>	<b>delay between receiving of a MA from Euroloop and the update of EOA/LOA on-board</b>
Start Event	A) On-board EUROLOOP receiver knows loop spectrum code, and B) Loop signal becomes available to the on-board, and C) On-board Euroloop receiver is not yet synchronised
Stop Event	Indication to the driver
Value	< 3.0 sec
Notes	It is assumed that the update of the EOA/LOA is required by the message received. The value indicated in this case includes additional delay for the display of the information.

5.2.1.6 Delay between receiving of an emergency message and applying the reaction on-board

<b>Description</b>	<b>delay between receiving of an emergency message and applying the reaction on-board</b>
Start Event	Reception of the complete message at the FRMCS on-board equipment/GSM-R mobile - ETCS on-board interface
Stop Event	Indication to the driver and/or beginning of issuing of braking order, if required
Value	< 1 sec, for brake order < 1.5 sec, for indication to the driver
Notes	The value given in the case of indication to the driver includes additional delay for the display of the information.

5.2.1.7 Delay between receiving of a radio message and initiating a communication session establishment

<b>Description</b>	<b>delay between receiving of a radio message and initiating a communication session establishment</b>
Start Event	Reception of the complete message at the FRMCS on-board equipment/GSM-R mobile - ETCS on-board interface
Stop Event	Beginning of sending of the connection request at the FRMCS on-board equipment/GSM-R mobile - ETCS on-board interface
Value	< 1 sec
Notes	It is assumed that the establishment of the communication session is required by the message received. This performance applies in the case of RBC/RBC handover.

5.2.1.8 Delay between passing an EOLM and decoding of the first loop message

<b>Description</b>	<b>delay between passing an EOLM and decoding of the first loop message</b>
Start Event	The reference mark of the on-board antenna leaving the “side lobe zone” of the last balise of the group giving the EOLM packet (1.3 m from the reference mark of the balise)
Stop Event	Indication to the driver (update of EOA/LOA, according to the new MA received)
Value	≤ 4 sec
Notes	It is assumed that the loop signal is received latest 1.0 s after the defined start event. In case the signal is present earlier than the delay, the train will not exploit the full length of the Euroloop cable. The value indicated in this case includes additional delay for the display of the information.

5.2.1.9 Delay between receiving of a balise group message and taking into account its content

<b>Description</b>	<b>delay between receiving of a balise group message and taking into account its content, so as to avoid a trip due to the overpassing of the EOA (level 1 only), the LOA, or the former EOA/LOA</b>
Start Event	The min safe antenna position passes an EOA/LOA location or a former EOA/LOA location a time $T_n$ , calculated from the formulas in Subset-036 clause 4.2.9, after the reference mark of the on-board antenna left the “side lobe zone” of the last balise in the group (1.3 m from the reference mark of the balise)
Stop Event	1 sec after the min safe antenna position has passed the EOA/LOA (or the former EOA/LOA) location, no issuance of the emergency braking order on the TIU-train interface.
Value	Not relevant.

Notes	<p>It is assumed that:</p> <ul style="list-style-type: none"> <li>• The last balise in the group is placed in such a way that the start event is fulfilled regardless of the engineering rule SUBSET-040 § 4.1.1.4.</li> <li>• The train is operating in level 1/ FS mode (level 1 / SR mode for the case of the former EOA/LOA).</li> <li>• The balise group message includes an extension of MA, an immediate level transition order to level 0/NTC or a “Stop if in SR” information.</li> </ul> <p>The fulfilment of this performance requirement is obtained by checking that the emergency brake is not activated, as a result from the MA extension, the level transition to level 0/NTC or the deletion of the former EOA/LOA which takes precedence on the overpassing of the EOA/LOA / former EOA/LOA (by virtue of the clause SUBSET-026 § A.3.5.2) and which is taken into account by the on-board no later than the latest time when the emergency brake can be activated due to the overpassing of the EOA/LOA/former EOA/LOA, as per section 5.2.1.13.</p>
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#### 5.2.1.10 Delay between driver action and new window displayed to driver

Description	Delay between driver action and new window displayed
Start Event	Driver action on DMI
Stop Event	New window is displayed
Value	≤ 2 sec
Notes	<p>It is assumed that the desk has been open for sufficient time to ensure that there are no running background tests still to be completed, see 5.2.1.12.</p> <p>This requirement only applies to driver actions which directly (i.e. with no display of hour glass) lead to a new window on the ETCS DMI (refer to ERA_ERTMS_015560).</p>

5.2.1.11 Awakening performance parameter #1

Description	Awakening performance parameter #1
Start Event	Desk becomes open
Stop Event	"enter Driver ID" is displayed
Value	≤ 3 sec
Notes	"Desk becomes open" means that the information is available on the Train Interface.

5.2.1.12 Awakening performance parameter #2

Description	Awakening performance parameter #2
Start Event	Desk becomes open
Stop Event	SH mode is displayed
Value	≤ 15 sec
Notes	<p>"Desk becomes open" means that the information is available on the Train Interface.</p> <p>Using the shortest path through the SoM procedure:</p> <ul style="list-style-type: none"> <li>• Train is in Level 1;</li> <li>• Level and stored position are valid;</li> <li>• Driver data entries are limited to Driver ID and SH request.</li> </ul> <p>The performance value stated above excludes the time taken by the driver to complete the 2 data entries.</p> <p>This parameter quantifies by how much any background tests can affect the Start of Mission performance (in this case the time to display a new window further to a driver data entry could be longer than the performance parameter specified in 5.2.1.10)</p>



## 5.2.1.13 Delay between passing an EOA (level 1 only), an LOA, or a former EOA/LOA and applying the emergency brake

<b>Description</b>	<b>delay between passing an EOA (level 1 only), an LOA, or a former EOA/LOA and applying the emergency brake</b>
Start Event	The min safe antenna position (level 1) has passed an EOA/LOA location or a former EOA/LOA location, or the min safe front end position (level 2) has passed an LOA location or a former EOA/LOA location
Stop Event	Beginning of issuing of the braking order on the TIU-train interface
Value	< 1 sec
Notes	The activation of the emergency brake results from the transition to the Trip mode.

## 5.3 Accuracy

### 5.3.1.1 Accuracy of distances measured on-board

<b>Description</b>	<b>Accuracy of distances measured on-board</b>
Start Event	not applicable
Stop Event	not applicable
Value	<p>for every measured distance <math>s</math> the accuracy shall be better or equal to <math>\pm (5m + 5\% s)</math>, i.e. the over reading amount and the under reading amount shall be equal to or lower than <math>(5m + 5\% s)</math>.</p> <p>Reference point (normally a balise group location reference)</p> <p>measured distance (s)</p> <p>over-reading amount</p> <p>under-reading amount</p> <p>Front end</p>
Notes	<p>This performance requirement includes the error for the detection of a balise location, as defined in the Eurobalise specifications.</p> <p>Also in case of malfunctioning the on-board equipment shall evaluate a safe confidence interval.</p>

### 5.3.1.2 Accuracy of speed known on-board

Description	accuracy of speed known on-board
Start Event	not applicable
Stop Event	not applicable
Value	$\pm 2$ km/h for speed lower than 30 km/h, then increasing linearly up to $\pm 12$ km/h at 500 km/h.
Notes	Only in target speed monitoring when the compensation of the speed measurement inaccuracy is not inhibited: the on-board equipment shall also evaluate a safe confidence interval in case of malfunctioning.

### 5.3.1.3 Age of speed and position measurement for position report to trackside

Description	age of speed and position measurement for position report to trackside
Start Event	not applicable
Stop Event	not applicable
Value	The speed and the position of the train front indicated in a position report shall be estimated less than 1 sec before the beginning of sending of the corresponding position report.
Notes	

## 5.3.2 Clock

### 5.3.2.1 Safe clock drift

Description	safe clock drift
Start Event	not applicable
Stop Event	not applicable
Value	0.1 %
Notes	This value is not only a performance but also a safety related requirement as it refers to clock information used for time-stamping of messages and for supervision of time-outs, the magnitude of which is a few minutes. Time Stamp resolution is defined in SUBSET-026.