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Aeronavtika - Delovanje sprejemnikov SBAS za pomorske aplikacije - poročilo o preskusu MARESS

Space — SBAS receivers performances for maritime applications — MARESS Test report

Raumfahrt - Leistung von SBAS-Empfängern für maritime Anwendungen - MARESS-Testbericht

Espace Performances des récepteurs SBAS pour les applications maritimes Rapport d'essais MARESS

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Space - SBAS receivers performances for maritime applications - MARESS Test report

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This draft Technical Report is submitted to CEN members for Vote. It has been drawn up by the Technical Committee CEN/CLC/JTC 5.

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European foreword

This document (FprCEN/TR 18104:2024) has been prepared by Technical Committee CEN/JTC 5 “Space”, the secretariat of which is held by BNAE.

This document is currently submitted to the Vote on TR.

Introduction

This technical document MARESS D2.2 has been prepared by European Satellite Services Provider (ESSP) in the scope of MARitime Receiver SBAS Standardization (MARESS) project to support International Standard IEC 61108-7 for SBAS receiver equipment. The purpose of this document is to present it in CEN/CENELEC JTC5/WG8 working group to support standardization process within IEC technical committee 80: Maritime navigation and radiocommunication equipment and systems.

Note at the time of the Publication: The outcome of this report has been already considered in the development of the IEC 61108-7 standard. This implies that these results are obsolete since in the current version of the IEC 61108-7 some requirements and tests have been updated.

1 Scope

The objective of this document is to present the results of the tests defined in the IEC 61108-7 draft [1] performed with a maritime receiver updated based on the SBAS maritime guidelines [2] and other GNSS SBAS receivers.

The list of test scenarios prepared, the receiver analysed, the configuration used and procedures are included in Clause 4. In Clause 5, graphical and numerical results for each of the test performed are presented, including if the tests are passed or failed. Annex A provides additional information on the test case setup.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp/

— IEC Electropedia: available at https://www.electropedia.org/

4 Test scenarios

4.1 General

The test scenarios implemented in MARESS project have been based on the MARESS deliverable D2.1 Methods of testing and required results [1].

In this Clause, all the tests performed are listed including the respective configuration used. All the tests have been prepared to process GPS L1 and SBAS L1.

The following information can be found for each of the tests executed:

- start date: indicate the start date of the scenario under test;
- duration: indicate the duration of the test;
- signal source: specify if the receiver was connected to real signals with a GNSS antenna in ESSP roof (Madrid) or if the GNSS simulator has been used to generate the GNSS and SBAS signals;
- data source: indicate if real data has been used as input (GPS RINEX and EGNOS EMS files); or the data has been automatically generated by the GNSS simulator (synthetic data);
- receiver position: provides the position of the receiver (real or simulated);
- specific configuration related with the objective of the test;
- outputs to be analysed: list of parameters to be retrieved from the receiver under test to check if the test is passed/failed.

4.2 Test cases

4.2.1 Test case #1: static accuracy and availability

The objective of this test is to check the static accuracy and availability of the receiver when providing SBAS PVT solution.

Table 1 provides specific information on the test characteristics and configuration:

Table 1 — Test case #1 — Scenario configuration

Start date	N/A (variable)
Duration	> 86 400 epochs
Signal source	Real RF L1 Signal
Data source	Real Data
Receiver position	Lat = 40.472° Lon = −3.452° Height = 661,1 m
Specific configuration	NMEA output rate: 1 Hz Static receiver
Outputs	Epoch PVT solution mode Position

All the outputs from the receivers are obtained through NMEA messages.

The start date is variable since it depends on when the receiver was connected to the antenna located in the roof of ESSP premises in Madrid.

The results of this test are included in subclause 5.2.1.

4.2.2 Test case #2: static accuracy with angular movement

The objective of this test is to check the static accuracy and availability of the receiver providing SBAS PVT solution when the antenna is performing an angular displacement of 22.5°, simulating roll, in a period of 8 s during the duration of the test.

Table 2 provides specific information on the test characteristics and configuration.

Table 2 — Test case #2 — Scenario configuration

Start date	02-Apr-2021 23:50:00
Duration	87 000 epochs
Signal source	GNSS simulator
Data source	Synthetic data
Receiver position	Lat = 40.467° Lon = −3.45° Height = 661,28 m
Specific configuration	NMEA output rate: 1 Hz Static receiver Antenna with angular movement (±22.5° during 8 seconds).
Outputs	Epoch PVT solution mode Position

Figure 1 shows a snapshot of the antenna movement configured in the GNSS simulator.

Figure 1 — Snapshot of GNSS simulator for antenna movement

Errors have not been introduced in the GPS signals and so, the position error is expected to be more accurate compared to a real scenario. However, the objective of the test is to check that the error is not increased when the antenna performs the angular movements in comparison with a nominal static scenario.

All the outputs from the receivers are obtained through NMEA messages.

The results of this test are included in subclause 5.2.2.

4.2.3 Test case #3: dynamic accuracy

4.2.3.1 General

The objective of this test is to check the dynamic accuracy of the receiver providing SBAS PVT solution.

Table 3 provides specific information on the test characteristics and configuration.

Table 3 — Test case #3 — Scenario configuration

Start date	03-Apr-2021 00:00:00
Duration	86 400 epochs
Signal source	GNSS simulator
Data source	Synthetic data
Receiver position	Dynamic position (refer to Table 4)
Specific configuration	NMEA output rate: 1 Hz Receiver in movement (refer to Table 4)
Outputs	Epoch PVT solution mode Position Truth position (from GNSS simulator)

The minimum requirement for the receiver movement described in D2.1 [1] is:

1. A fully locked and settled EUT travelling in a straight line at 48 kn ± 2 kn for a minimum of 1,2 minutes which is reduced to 0 kn in the same straight line in 5 s.

In order to comply with this, the receiver in the GNSS simulator has been configured to perform the following movements:

Table 4 — Test case #3 — Ship movement configuration

	Ship dynamics	Period of time
Start position (step 0)	Lat = 41.517° Lon = 3.65° Height = 300 m	N/A
Step 1	Ship in halt	300 s
Step 2	Ship accelerating (max speed 25 m/s)	60 s
Step 3	Ship at constant speed (25 m/s)	120 s
Step 4	Ship reduce velocity until it stops (0 m/s)	5 s
Step 5	Ship in halt	120 s
Step 6	Repeat steps 2, 3, 4 and 5 consecutively.	

It is clarified that the ship movement configured is only at horizontal level.

In addition, the latitude of the receiver position is maintained during the whole scenario, the movement described in previous table only implies changes in the longitude.

Figure 2 shows a snapshot of the ship trajectory configured in the GNSS simulator.

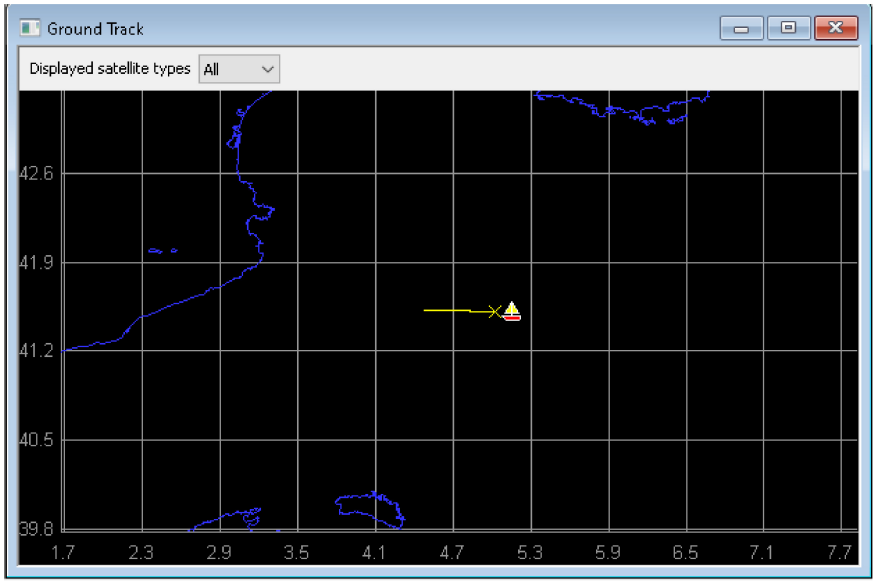

Figure 2 — Snapshot of ship trajectory for dynamic movement scenario

Errors have not been introduced in the GPS signals and so, the position error is expected to be more accurate compared to a real scenario. However, the objective of the test is to check that the receiver follows the dynamics of the ship. Nevertheless, in order to ensure that the receiver will correctly pass the test under a more realistic scenario. A Test case #3b was prepared (refer to subclause 4.2.3.1).

All the outputs from the receivers are obtained through NMEA messages. In this case, the GNSS simulator has been configured to provide also the truth position (through NMEA) during the whole scenario.

The results of this test are included in subclause 5.2.2.

4.2.3.2 Test case #3b: dynamic accuracy with input files

This test case was performed in order to check if the receiver correctly follows the ship dynamics when GPS RINEX and EGNOS EMS real data are used as input files in the GNSS simulator.

However, during the scenario executions, a limitation was found on the GNSS simulator. If real data are used as input, the GNSS simulator uses the GPS RINEX files for two purposes:

1. include the RINEX content into the GPS navigation messages;

2. generate the real GPS orbits.

Since the GNSS simulator uses the GPS RINEX, where the GPS messages have ephemeris/clock errors that SBAS will correct, to generate the real GPS orbits in the simulation, the SBAS corrections are not needed. Indeed, SBAS corrections increase the error in the position since SBAS is correcting errors that do not exist in the simulation. The same situation it occurs with the ionosphere, since the ionosphere generated by the simulator does not match with the ionospheric corrections delivered by SBAS. The GNSS simulator manufacturer was contacted to correct this issue, but it is confirmed that this is a limitation from the GNSS simulator.

In any case, this can be considered as a worst-case scenario, and so, it can be used to validate the test under analysis.

Table 5 provides specific information on the test characteristics and configuration:

Table 5 — Test case #3b — Scenario configuration

Start date	03-Apr-2021 00:00:00
Duration	86 400 epochs
Signal source	GNSS simulator
Data source	Real data
Receiver position	Dynamic position (refer to Table 4)
Specific configuration	NMEA output rate: 1 Hz Receiver in movement (refer to Table 4)
Outputs	Epoch PVT solution mode Position Truth position (from GNSS simulator)

All the outputs from the receivers are obtained through NMEA messages. In this case, the GNSS simulator has been configured to provide also the truth position (through NMEA) during the whole scenario.

The results of this test are included in subclause 5.2.3.1.

4.2.4 Test case #4: acquisition

The objective of this test is to check the acquisition time required by the receiver to provide SBAS PVT solution.

Table 6 provides specific information on the test characteristics and configuration.

Table 6 — Test case #4 — Scenario configuration

Start date	N/A (variable)
Duration	> 86 400 epochs
Signal source	Real RF L1 Signals
Data source	Real data
Receiver position	Lat = 40.472° Lon = −3.452° Height = 661,1 m
Specific configuration	NMEA output rate: 1 Hz Static receiver
Outputs	Epoch PVT solution mode Position

Since the requirement included in D2.1 [1] refers to acquisition time when there is valid almanac, the test has been done based on the following steps:

1. wait for the receiver to provide SBAS PVT solution;
2. remove connection to the antenna between 24 and 25 hours;
3. connect again the antenna to the receiver under test;
4. check the time required from connection to provide SBAS PVT solution.

All the outputs from the receivers are obtained through NMEA messages.

The start date is variable since it depends on when the receiver was connected to the antenna located in the roof of ESSP premises in Madrid.

The results of this test are included in subclause 5.2.4.

4.2.5 Test case #5: dynamic range

This test is aimed at checking that the receiver is able to track the SBAS signal between the maximum and minimum power levels indicated in D2.1 [1].

Table 7 provides specific information on the test characteristics and configuration.

Table 7 — Test case #5 — Scenario configuration

Start date	03-Apr-2021 00:00:00
Duration	1 800 epochs
Signal source	GNSS simulator
Data source	Synthetic data
Receiver position	Lat = 40.467° Lon = −3.45° Height = 661,28 m
Specific configuration	NMEA output rate: 1 Hz Static receiver 2 SBAS PRNs Signal power modified during scenario (refer to Table 8)
Outputs	Epoch PVT solution mode C/N_0

In this scenario, two SBAS PRNs have been configured: PRN 123 and PRN 136 (corresponding to EGNOS SBAS). In order to ensure that the receiver complies with the requirement, the signal power of the SBAS satellites has been modified during the execution. The test has been done based on the following steps:

Table 8 — Test case #5 — SBAS signal power modifications

	PRN 123	PRN 136
Start – 00:00:00	−120 dBm	−130 dBm
Step 1 – 00:10:00	−123 dBm	−133 dBm
Step 2 – 00:12:00	−130 dBm	−120 dBm
Step 3 – 00:14:00	−133 dBm	−133 dBm

All the outputs from the receivers are obtained through NMEA messages.

The results of this test are included in subclause 5.2.5.

4.2.6 Test case #6: position update

4.2.6.1 General

The objective of this test is to check that receiver provides SBAS PVT solution at the required rate.

Two different sub test cases are identified to check the position update requirement, one related with low-speed crafts and other one for high-speed crafts.

4.2.6.2 Test case #6a: low-speed crafts

Table 9 provides specific information on the test characteristics and configuration.

Table 9 — Test case #6a — Scenario configuration

Start date	03-Apr-2021 00:00:00
Duration	1 101 epochs
Signal source	GNSS simulator
Data source	Synthetic data
Receiver position	Dynamic position (refer to Table 10)
Specific configuration	NMEA output rate: 1 Hz Receiver in movement (refer to Table 10)
Outputs	Epoch PVT solution mode Position

In D2.1 [1] is required to perform the test with a receiver travelling in a straight line at 5 kn ± 1 knot. In order to comply with this, the receiver in the GNSS simulator has been configured to perform the following movements: