Bundesrepublik Deutschland
Federal Republic of Germany

Bundesamt für Seeschifffahrt und Hydrographie
Federal Maritime and Hydrographic Agency

BUNDESAMT FÜR SEESCHIFFFAHRT UND HYDROGRAPHIE

Conformance test report of a

GPS receiver modul

integrated in an

AIS Transponder

Equipment under test:	ICOM AIS class B
Type:	MA-500TR
Applying test standards:	IEC 61108-1:2003
Test Report No.:	BSH/46162/4321440/10-2
Applicant:	Pete Hizzey 5 Boulevard Libre Echange, 2AC Champs Pinsons 31650 Saint-Orens de Gameville France

Hamburg, 3rd December 2010

by order
Federal Maritime and Hydrographic Agency
by order

Tobias Ehlers
Test engineer

Jochen Ritterbusch
Head of Laboratory

nach DIN EN 17025
akkreditiertes Prüflaboratorium

Deutscher Akkreditierungs Rat
DAR

DAT-PL-086/98-02

Federal Maritime and Hydrographic Agency
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Signatory of the Multilateral Agreement of EA and ILAC for the mutual recognition

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Deutschen AkkreditierungsRat

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Frankfurt/Main, 2008-12-23

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i.V. Dipl.-Ing.(FH) R. Egner
Head of the Accreditation Body

Member in EA, ILAC, IAF

Translation for information purposes only. The German Accreditation Certificate is authoritative

See notes overleaf

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1 General

Applicant:	Pete Hizzey 5 Boulevard Libre Echange 2AC Champs Pinsons 31650 Saint-Orens de Gameville France
Equipment under test:	ICOM AIS class B
Type:	MA-500TR
Manufacturer:	ICOM Incorporated 2-1-32 Kamiminami, Hirano-Ku Osaka 547-0003 Japan
Place of test:	BSH test laboratory Hamburg, Room 908/ 042
Start of test:	16th July 2010
End of test:	21st October 2010

1.1 Summery

Test standard: IEC 61108-1 Ed. 2, 2003

Test No.	Reference	Section	Result (passed/ not passed / not applicable / not tested)
1	IEC 61108-1	4.1 Object compliance with IEC 61162-1 compliance with IEC 60945	not tested
2/16	IEC 61108-1	4.2 GPS receiver equipment	passed
3/17	IEC 61108-1	4.3.1 General	passed
4/18	IEC 61108-1	4.3.2 Equipment output	not applicable
5/19-23	IEC 61108-1	4.3.3 Accuracy	passed
6/24-27	IEC 61108-1	4.3.4 Acquisition	passed
7/28	IEC 61108-1	4.3.5 Protection	passed
8/29	IEC 61108-1	4.3.6 Antenna design	passed
9/30-31	IEC 61108-1	4.3.7 Dynamic range	passed
10/32-33	IEC 61108-1	4.3.8 Effects of specific interfering signals	passed
11/34-35	IEC 61108-1	4.3.9 Position update	passed
12/36	IEC 61108-1	4.3.10 Differential GPS input	not applicable
13/37-40	IEC 61108-1	4.3.11 Failure warnings and status indications	passed[1]
14/41-42	IEC 61108-1	4.3.12 Output of COG, SOG and UTC	passed
15/43-44	IEC 61108-1	4.3.13 Typical interference conditions	passed

[1] EUT is an AIS class B, no RAIM mode available, RAIM functionality tested by position output evaluation during RAIM scenario, see Annex B.7 for details.

1.2 Equipment history

Transponder Unit – Equipment No. 1				
Type	**MA-500TR**	**Part No.:**	**---**	
Delivery date	**2010-05-19**	**Serial number**	**000043**	
HW Version:	**Delivery date**	**2010-05-19**	**Version no**	
	Installation date	**2010-07-23**		
SW Version:	**Delivery date**	**2010-05-19**	**Version no**	**SW: 1.002**
	Installation date	**2010-07-23**		
SW Version:	**Delivery date**	**2010-07-19**	**Version no**	**SW:1.005**
	Installation date	**2010-07-23**		
SW Version:	**Delivery date**		**Version no**	
	Installation date			
SW Version:	**Delivery date**		**Version no**	
	Installation date			

GPS antenna				
Type	**ICOM MXG 5000**	**Part No.:**		
Delivery date	**2010-05-19**	**Serial number**	**0000315**	
HW Version:	**Delivery date**		**Version no**	**Includes the GPS receiver**
	Installation date			

Transponder Unit – Equipment No. 2				
Type	**MA-500TR**	**Part No.:**	**---**	
Delivery date	**2010-09-02**	**Serial number**	**09001022**	
HW Version:	**Delivery date**	**2010-09-02**	**Version no**	
	Installation date	**2010-09-30**		
SW Version:	**Delivery date**	**2010-09-02**	**Version no**	**SW: 1.007**
	Installation date	**2010-09-30**		
SW Version:	**Delivery date**		**Version no**	
	Installation date			
SW Version:	**Delivery date**		**Version no**	
	Installation date			

GPS antenna				
Type	**ICOM MXG 5000**	**Part No.:**		
Delivery date	**2010-09-24**	**Serial number**	**0301057**	
HW Version:	**Delivery date**	**2010-09-24**	**Version no**	**Includes the GPS receiver**
	Installation date	**2010-09-30**		

1.3 Test environment

Documentation of equipment tests and dates of tests.
Test environment is completely equipped as described in Annex A.

Room	**BSH room 908/ 042**
Test engineer	**T. Ehlers (S3301)**
Location	**Hamburg**

Equipment no	Start of test	End of test	Test engineer
1	**16th July 2010**	**30th Sept. 2010**	**T. Ehlers (S3301)**
2	**20th Oct. 2010**	**21st Oct. 2010**	**T. Ehlers (S3301)**

1.4 Legend

Result marking (in the "result" column)[2]:

Passed	Item was OK, test successful No colour marking
Not passed	Test of a required item was not successful, change required
N/T	Not tested
N/A	Not applicable

Specific remarks (in the "remark" column, marked "bold italic"):

REC	recommendation (in terms of IEC17025 "opinion"); an improvement or change is recommended
Note	Note or comment (in terms of IEC17025 "interpretation");rationale for specific results or interpretation of requirements as appropriate

1.5 General observations

General observations unrelated to any paragraphs of applied test standards.

[2] Test items maybe colour marked in draft versions of the report as follows:

Passed	no colour marking
Not passed	yellow
N/T	blue
N/A	no colour marking
REC	green

2 Functional Tests

2.1 IEC 61108-1

No. of test	IEC 61108-1	Requirement/Condition	Remark	Result
	4	**Minimum Performance Standards**		
1	**4.1**	**Object** **compliance with IEC 61162-1 (see §2.3)** **compliance with IEC 60945**		 **N/T** **N/T**
2	**4.2**	**GPS Receiver equipment**		
	4.2.1	**(M.112/A2.1) The words "GPS receiver equipment" as used in this performance standard include all the components and units necessary for the system to properly perform its intended functions. The equipment shall include the following minimum facilities:** **a) antenna capable of receiving GPS signals;** **b) GPS receiver and processor;** **c) means of accessing the computed latitude/longitude position;** **d) data control and interface; and** **e) position display and, if required, other form of output.**	**NOTE** EUT is an AIS with integrated GPS-Receiver and serial interface for data output See also test results under test no. 16.	**Passed**
	4.2.2	**The equipment may be supplied in one of the several configurations to provide the necessary position information. Examples are:** **stand-alone receiver with means of accessing computed position via a keyboard with the position information suitably displayed;** **GPS black box receiver fed with operational parameters from external devices/remote locations and feeding an integrated system with means of access to the computed position via an appropriate interface, and the positional information available to at least one remote location.** **The above examples should not be implied as limiting the scope of future development.**	**NOTE** EUT is an AIS with integrated GPS receiver See also test results under test no. 16	**Passed**

	4.3	**Performance standard for GPS receiver equipment**		
3	**4.3.1**	**General** **(M.112/A3.1) The GPS receiver equipment shall be capable of receiving and processing the Standard Positioning Service (SPS) and provide position information in latitude and longitude World Geodetic System (WGS 84) co-ordinates in degrees, minutes and thousandths of minutes and time of solution referenced to UTC (USNO). Means may be provided to transform the computed position based upon WGS-84 into data compatible with the datum of the navigational chart in use. Where this facility exists, the display shall indicate that co-ordinate conversion is being performed and shall identify the co-ordinate system in which the position is expressed.** **(M.112/A3.2) The GPS receiver equipment shall operate on the L1 signal and C/A code.**	See also test results under test no. 17.	**Passed**

4	**4.3.2**	**Equipment output** **(M.112/A3.3) The GPS receiver equipment shall be provided with at least one output from which position information can be supplied to other equipment. The output of position information based upon WGS-84 shall be in accordance with International Standards - IEC 61162** **The position information output shall be in accordiance with IEC 61162 as follows:** **For positioning reporting purposes the following sentences shall be available in any combination.** **DMT – Datum reference** **GBS – GNSS satellite fault detection** **GGA – GPS fix data** **GNS – GNSS fix data** **RMC – Recommended minimum specific GNSS data** **VTG – Course over ground and ground speed** **ZDA – Time and date** **If a sentences uses a datum other than WGS-84 then the DTM sentence must be used in compliance with IEC 61162.** **In addition, for integrating with other navigational aids the following sentences may be available in any combination.** **GRS – GNSS range residuals** **GSA – GNSS DOP and active satellites** **GST – GNSS pseudorange error statistics** **GSV – GNSS satellites in view** **NOTE GRS, GSA, GST, GSV are required to support external integrity checking. They are to be synchronized with corresponding fix data (GGA or GNS).**	**NOTE** EUT is equipped with a serial interface for AIS data output.	**N/T**

5	**4.3.3**	**Accuracy**		
	4.3.3.1	**Static Accuracy** **(M.112/A3.4) The GPS receiver equipment shall have static accuracy such that the position of the antenna is determined to 100 m (95 %) with horizontal dilution of position (HDOP)≤4 (or PDOP≤6). Since Selective Availability has been set to zero, the static accuracy has been determined to be within 13 m (95 %) as specified by the GPS SPS Performance Standards of October 2001.**	See test results under test no. 19 – 21.	**Passed**
	4.3.3.2	**Dynamic Accuracy** **(M.112/A3.5) The GPS receiver equipment shall have dynamic accuracy such that the position of the antenna is determined to within an accuracy of 100 m (95 %) with HDOP ≤ 4 (or PDOP ≤ 6) under the conditions of sea state and ship's motion likely to be experienced in ships (see IMO Resolution A.694, IEC 60721-3-6 and IEC 60945). Since Selective Availability has been set to zero, the dynamic accuracy has been determined to be within 13 m (95 %) as specified by the GPS SPS Performance Standards of October 2001.**	See test results under test no. 22 and 23.	**Passed**
6	**4.3.4**	**Acquisition** **(M.112/A3.6) The GPS receiver equipment shall be capable of selecting automatically the appropriate satellite transmitted signals for determination of the ship's position with the required accuracy and update rate.** **(M.112/A3.8) The GPS receiver equipment shall be capable of acquiring position to the required accuracy, within 30 min, when there is no valid almanac data.** **(M.112/A3.9) The GPS receiver equipment shall be capable of acquiring position to the required accuracy, within 5 min, when there is valid almanac data.** **(M.112/A3.10) The GPS receiver equipment shall be capable of re-acquiring position to the required accuracy, within 5 min, when the GPS signals are interrupted for a period of at least 24 h, but there is no loss of power.** **(M.112/A3.11) The GPS receiver equipment shall be capable of re-acquiring position to the required accuracy, within 2 min, when subjected to a power interruption of 60 s.** **Acquisition is defined as the processing of GPS satellite signals to obtain a position fix within the required accuracies.** **Four conditions of the GPS receiver equipment are set out under which the minimum performance standards shall be met.**	See test results under test no. 24 - 27	

		Condition A **Initialization - the equipment has been transported over large distances (>1 000 km to <10 000 km) without power or GPS signals or by the deletion of the current almanac; or not been powered for >7 days** **Condition B** **Power outag: under normal operation the equipment losses power for at least 24 h.** **Condition C** **Interruption of GPS signal reception - under normal operation the GPS signal reception is interrupted for at least 24 h, but there is no loss of power.** **Condition D** **Brief interruption of GPS signals for 60 s.** **No user action other than applying power and providing a clear view from the antenna for the GPS signals, shall be necessary, from any of the initial conditions above, in order to achieve the required acquisition time limits in Table 1:** **A: 30 minutes** **B: 5 minutes** **C: 5 minutes** **D: 2 minutes**		**Passed** **Passed** **Passed** **Passed**
7	**4.3.5**	**Protection**		
	4.3.5.1	**Antenna and input/output connections (M.112/A4)** **Precautions shall be taken to ensure that no permanent damage can result from an accidental short circuit or grounding of the antenna or any of its input or output connections or any of the GPS receiver equipment inputs or outputs for a duration of 5 min.**	See test results under test no. 28.	**Passed**
8	**4.3.6**	**Antenna design** **(M.112/A2.2) The antenna design shall be suitable for fitting at a position on the ship which ensures a clear view of the satellite constellation.**	See test results under test no. 29.	**Passed**
9	**4.3.7**	**Dynamic range** **(M.112/A3.7) The GPS receiver equipment shall be capable of acquiring satellite signals with input signals having carrier levels in the range of –130 dBm to –120 dBm as measured at the output of a 3 dBi linear polarized receiving antenna. Once the satellite signals have been acquired the equipment shall continue to operate satisfactorily with satellite signals having carrier levels down to –133 dBm as measured at the output of a 3 dBi linear polarized receiving antenna.**	See test results under test no. 30 and 31.	**Passed**

10	**4.3.8**	**Effects of specific interfering signals** **The GPS receiver equipment shall meet the following requirements:** **a) In a normal operating mode, i.e. switched on and with antenna attached, it is subject to radiation of 3 W/m² at a frequency of 1 636.5 MHz for 10 min. When the unwanted signal is removed and the GPS receiver antenna is exposed to the normal GPS satellite signals, the GPS receiver equipment shall calculate valid position fixes within 5 min without further operator intervention.** **b) In a normal operating mode, i.e. switched on and with antenna attached, it is subject to radiation consisting of a burst of 10 pulses, each 1.0 µs to 1.5 µs long on a duty cycle of 1600:1 at a frequency lying between 2.9 GHz and 3.1 GHz at power density of about 7.5 kW/m². The condition shall be maintained for 10 min with the bursts of pulses repeated every 3 s. When the unwanted signal is removed and the GPS receiver antenna is exposed to the normal GPS satellite signals, the receiver shall calculate valid position fixes within 5 min without further operator intervention.** **Advice shall be given in the manual for adequate installation of the antenna unit, to minimise interference with other radio equipment such as marine radars, Inmarsat SES´s, etc.**	See test results under test no. 32. **NOTE** (Condition B) This condition is approximately equivalent to exposing the antenna to radiation from a 60kW 'S' band marine radar operating at a nominal 1,2µs pulse width at 600 pulses/s using a 4m slot antenna rotating at 20r/min with the GPS antenna placed in the plane of the bore site of the radar antenna at a distance of 10m from the centre of rotation.	**Passed** **Passed**
11	**4.3.9**	**Position update** **(M.112/A3.12) The GPS receiver equipment shall generate and output to a display and digital interface a new position solution at least once every 1 s.** **(M.112/A3.13) The minimum resolution of position i.e. latitude and longitude shall be 0.001 min.**	**NOTE** For craft meeting the HSC code, a new position solution at least every 0.5 s is recommended. See test results under test no. 34 and 35.	**Passed**

12	**4.3.10**	**Differential GPS input** **(M.112/A3.15) The GPS receiver equipment shall have the facilities to process differential GPS (DGPS) data fed to it in accordance with the standards of Recommendation ITU-R M.823 and an appropriate RTCM standard.** **When a GPS receiver is equipped with a differential receiver, performance standards for static and dynamic accuracy (M.112/A3.4 and A3.5) shall be 10 m (95 %) together with integrity monitoring.** **An integrated DGPS receiver shall have an ITU-R M823 compliant data output port for testing or alternatively, a possibility to display Word Error Rate (WER) on the integrated equipment. The WER is the number of incorrect ITU-R M.823 words in relation to total number of words received.**		**N/A**
13	**4.3.11**	**Failure warnings and status indications** **(M.112/A5.1) The equipment shall provide an indication if the position calculated is likely to be outside of the requirements of these performance standards;**		**N/A**
	4.3.11.1	**General** **(M112/A52) The GPS receiver equipment shall provide as a minimum:** **a) (M.112/A5.2.1) an indication within 5 s if either:** **1) the specified HDOP has been exceeded; or** **2) a new position has not been calculated for more than 1 s;** **3) under such conditions the last known position and the time of the last valid fix, with explicit indication of this state, so that no ambiguity can exist, shall be output until normal operation is resumed;** **b) (M.112/A5.2.2) a warning of loss of position; and** **c) (M.112/A5.2.3) differential GPS status indication of:** **1) the receipt of DGPS signals; and** **2) whether DGPS corrections are being applied to the indicated ship's position.** **d) (M112/A5.2.5) DGPS text message display. The GPS receiver either shall have as a minimum the capability of displaying appropriate DGPS text messages or forwarding those messages to for display on a remote system.**	**NOTE** EUT is an AIS class B **NOTE a2)** For craft meeting the HSC code, an new position solution at least every 0.5 s is recommended.	**N/A**

	4.3.11.2	**Integrity using RAIM** **The GPS receiver equipment shall incorporate integrity monitoring using fault detection, for example receiver autonomous integrity monitoring (RAIM), or similar means to determine if accuracy is within the performance standards and provide an integrity indication.** **An integrity indication shall be used to present the result of the integrity calculation with respect to the selected accuracy level appropriate for vessels operational mode. According to IMO Resolution A.815 these accuracy levels shall be user selectable for 10 m and 100 m. Additional accuracy levels for user selection may be provided.** **The integrity indication for different position accuracy levels shall be expressed in three states:** **"safe'** **"caution", and** **"unsafe"** **for the currently selected accuracy level with a 95 % confidence level.** **The integrity status shall be continuously displayed along with an indication of the accuracy level selected. The integrity status and the accuracy level selected, shall be provided to other equipment in accordance with the equipment output requirements in 4.3.2.** **The manufacturer may use colours for integrity indication and if so the following colours shall be used:** **"safe" shall be green,** **"caution shall be yellow, and** **"unsafe" shall be red.** **The maximum delay for reaction of the integrity calculation by means of RAIM due to negative changes affecting the integrity status is 10 s.** **The integrity status shall be provided to other equipment in accordance with the equipment output requirements in 4.3.2. For receiver equipment which do not provide information by a dedicated display, the provision of the integrity indication status and the selected accuracy level with the appropriate output interface is mandatory.**		**Passed**
	4.3.11.3	**GPS integrity status using DGPS** **(M.112/A5.2) The GPS receiver equipment shall provide as a minimum GPS integrity status using DGPS.** **If the range-rate correction or the pseudo range correction of a satellite is out of tolerance, the**		**N/A**

		binary code in the ITU-R M.823-2 types 1, 9, 31 and 34 messages will cause the GPS receiver not to use that satellite.		
	4.3.11.4	**DGPS integrity status and alarm** **(M.112/A5.2.4) The GPS receiver equipment shall provide as a minimum DGPS integrity status and alarm.** **The following functions shall be performed in either an integrated DGPS receiver or an associated GPS receiver connected to a DGPS radio beacon receiver.** **When in differential mode, the GPS receiver shall present a DGPS integrity indication on a display, or forward those messages for display on a remote system:** **if no DGPS message is received within 10 s;** **while in manual station selection mode and the selected station is unhealthy, unmonitored, or signal quality is below threshold;** **while in automatic station selection mode and the only available station is unhealthy, unmonitored, or signal quality is below threshold.**		**N/A**
14	**4.3.12**	**Output of COG, SOG and UTC** **(M.112/A3.14) The GPS receiver equipment shall generate and output to the digital interface (conforming to the IEC 61162 series) course over ground (COG), speed over ground (SOG) and universal time coordinated (UTC). Such outputs shall have a validity mark aligned with that on the position output. The accuracy requirement for COG and SOG shall no be inferior to the relevant performance standards for heading (Resolution A.424(XI)) and SDME (Resolution A.824/19)), within the limitations of GPS measurements provided by one antenna, compared to the requirements of those standards. Generation and output of COG and SOG are not intended to satisfy the carriage requirements of SOLAS, Chapter V for Heading Devices and SDME by GPS receivers. GPS receivers of this standard have limitations in COG accuracy under high dynamic movement. Such limitations shall be described in the manufacturer's operating manual as shown in Table 2.**		**N/A**
	4.3.12.1	**Accuracy of COG information** **The error in the COG (the path of the antenna position over ground) due to the actual ship's speed over ground shall not exceed the following values:** **Table 2:** **Speed range (knots) Accuracy of COG output to user**		**Passed**

		0 to ≤1 knot Unreliable or not available **>1 to ≤17 knots ±3°** **>17 knots ±1°** **Due to the limitations of GPS receivers of this standard, it is not appropriate to include requirements for COG errors attributed to high dynamic movement. Such limitations shall be in the manufacturer's operation manual.**		
	4.3.12.2	**Accuracy of SOG information** **Errors in the SOG (velocity of the antenna position over ground) shall not exceed 2 % of the actual speed or 0.2 knots, whichever is greater.**		**Passed**
	4.3.12.3	**Availability and validity of time information** **The GPS receiver equipment shall provide UTC with resolution of 0.01 s on the digital interface.** **The validity mark of the digital interface for position contained in GGA message of IEC 61162 shall be used for interpretation of validity of digital interface for UTC contained in ZDA message of IEC 61162.**		**N/A**
15	**4.3.13**	**Typical interference conditions** **(M.112/A3.16) The GPS receiver equipment shall be capable of operating satisfactorily in typical interference conditions.** **For clarification of this requirement see 5.7.1 and for the associated tests see 5.7.2.**	See test results under Test no. 43 and 44.	**Passed**
	5.6	**Methods of test and required test results**	**NOTE** The number in brackets is the sub-clause of the relevant performance standard.	
16	**5.6.1** **(4.2.1)**	**GPS receiver equipment** **The equipment under test (EUT) shall be checked for composition by inspection of the equipment and the manufacturer's documentation.**		**Passed**
17	**5.6.2** **(4.3.1)**	**Position output** **The EUT shall be checked for the form of the position output by inspection of the manufacturer's documentation.**		**Passed**
18	**5.6.3** **(4.3.2)**	**Equipment output** **The EUT shall be checked for conformity to IEC 61162-1 by inspection of the manufacturer's documentation and protocol tests.**		**N/T**

	5.6.4 (4.3.3)	**Accuracy**		
	5.6.4.1 (4.3.3.1)	**Static accuracy**		
19	**5.6.4.1.1**	**GPS** **Position fix measurements shall be taken over a period of not <24 h. The absolute horizontal accuracy shall be within 13 m (95 %), having discarded measurements taken in conditions of HDOP ≥ 4 and PDOP ≥ 6.**	**NOTE** The measurements were evaluated with regard to the precisely measured reference position on the roof of BSH. Accuracy requirements are met - see Annex B for printouts of the measurements for static accuracy in GPS mode.	**Passed**
20	**5.6.4.1.2**	**Differential GPS** **Position fix measurements shall be taken once per second over a period of not <24 h. The distribution of the horizontal error shall be within 10 m (95 %). The horizontal position of the antenna shall be known to within 0.1 m in the datum used for the generation of the corrections. The corrections shall be provided by an actual DGPS broadcast in accordance with ITU-R M.823.**		**N/A**
21	**5.6.4.2**	**Angular movement of the antenna** **The static tests specified in 5.6.4.1.1 and 5.6.4.1.2 shall be repeated with the antenna performing an angular displacement of ±22.5° (simulating roll) in a period of about 8 s (see IEC 60721-3-6) during the duration of the tests.**	**NOTE** The EUT antenna was mounted on a special motor driven support simulating the required roll motion at the roof of BSH. The measurements were evaluated with regard to the precisely measured reference position at the roof of the BSH. Accuracy requirements are met - see Annex B for printouts of the measurements for static accuracy in GPS mode	**Passed**

	5.6.4.3 (4.3.3.2)	**Dynamic accuracy**		
22	**5.6.4.3.1**	**GPS** **The tests for dynamic accuracy are a practical interpretation of the conditions set out in IEC 60721-3-6, Table V, item e), X-direction (surge) and Y-direction (sway). These are stated as surge 5 m/s² and sway 6 m/s² for all classes of environment. When using a simulator, the simulator characteristics shall accurately represent the signals required.** **The results of the test performed by simulation facilities shall be identical with those in a) and b) below.** **Alternatively to the use of a simulator, an example of applying these accelerations is given below:** **a) a fully locked and settled EUT travelling in a straight line at 48 knots ± 2 knots for a minimum of 1.2 min which is reduced to 0 knots in the same straight line in 5 s, shall not indicate a positional offset >±13 m from the final position 10 s after coming to rest;** **a fully locked and settled EUT travelling at least 100 m at 24 knots ± 1 knot in a straight line then subjected, for at least 2 min, to smooth deviations either side of the straight line of approximately 2 m at a period of 11 s to 12 s shall remain in lock and follow the actual position to within an lane of 30 m wide centred on the mean direction of motion.** **For all methods above, the rest position shall be established by one of the following methods:** **providing a stationary receiver identical to the EUT alongside the rest point and comparing indicated output positions; or** **providing the reference inputs from the simulator.**		**Passed**

23	**5.6.4.3.2**	**Differential GPS** **The tests for dynamic accuracy are a practical interpretation of the conditions set out in IEC 60721-3-6, Table V, item e), X-direction (surge) and Y-direction (sway). These are stated as surge 5 m/s² and sway 6 m/s² for all classes of environment. When using a simulator, the simulator characteristics shall accurately represent the signals required.** **The results of the test performed by simulation facilities shall be identical with those in a) and b) below.** **Alternatively to the use of a simulator, an example of applying these accelerations is given below:** **a fully locked and settled EUT travelling in a straight line at 48 knots ± 2 knots for a minimum of 1.2 min which is reduced to 0 knots in the same straight line in 5 s, shall not indicate a positional offset >±10 m from the true position at rest and the indicated position shall settle to within ±2 m of the rest position indication within 10 s of coming to rest;** **a fully locked and settled EUT travelling at least 100 m at 24 knots ± 1 knot in a straight line then subjected, for at least 2 min, to smooth deviations either side of the straight line of approximately 2 m at a period of 11 s to 12 s shall remain in lock and follow the actual position to within an lane of 30 m wide centred on the mean direction of motion.** **For the methods above, the true and rest positions shall be established by one of the following methods:** **a) for method a) above, the rest position indication shall be determined by averaging the 15 consecutive position indications recorded following the 10 s settling period and the true position at rest shall be measured to an accuracy of 1 m;** **b) providing the reference inputs from a simulator within 1 m.**		**N/A**
	5.6.5 (4.3.4)	**Acquisition**		
24	**5.6.5.1**	**Condition A - Initialisation** **The EUT shall be either:** **a) initialised to a false position at least 1 000 km and not greater than 10 000 km from the test position, or alternatively, by deletion of the current almanac; or** **b) isolated from a power source and GPS signals for >7 days.** **A performance check shall be carried out after the time limit contained in Table 1.**	**NOTE:** All Simulator tests force almanach reset	**Passed**

25	**5.6.5.2**	**Condition B - Power outage** **The EUT shall be isolated from the power source for a period within 24 h to 25 h.** **At the end of the period, a performance check shall be carried out after the time limit contained in Table 1.**		**Passed**
26	**5.6.5.3**	**Condition C - Interruption of GPS signals** **During normal operation of the EUT, the antenna shall be completely masked for a period within 24 h to 25 h.** **At the end of the period, a performance check shall be carried out after the time limit contained in Table 1.**		**Passed**
27	**5.6.5.4**	**Condition D – Brief interruption of power** **During normal operation of the EUT, the power shall be removed for a period of 60 s. At the end of this period, the power shall be restored.** **A performance check shall be carried out after the time limit contained in Table 1.**		**Passed**
	5.6.6 (4.3.5)	**Protection**		
28	**5.6.6.1 (4.3.5.1)**	**Antenna and input/output connections** **The antenna input of the receiver, if provided, shall be connected to ground for 5 min. After completion of the test and reset of the EUT, if required, the antenna or input/output connections shall be connected normally, and a performance check shall be carried out to ensure that no permanent damage has resulted.**		**Passed**
29	**5.6.7 (4.3.6)**	**Antenna design** **The antenna of the EUT shall be checked by inspection of the documentation provided by the manufacturer, to confirm that it is suitable for shipborne installation to ensure a clear view of the satellite constellation.**		**Passed**
	5.6.8 (4.3.7)	**Sensitivity and dynamic range**		
30	**5.6.8.1**	**Acquisition** **This is tested by using a simulator.** **Method:** **Transmit the simulator signal over a suitable antenna.** **Adjust the signal power by use of a calibrated test receiver to –125 dBm ± 5 dBm.** **Replace the antenna of the calibrated test receiver by the receiving unit of the EUT.** **A performance check shall be carried out.** **Required result:** **The EUT shall meet the requirements of this check, with this signal range.**		**Passed**

31	**5.6.8.2**	**Tracking** **The received satellite signals shall be monitored by a suitable test receiver. These signals shall be attenuated down to -133 dBm. Under these conditions the performance requirements of a performance check shall be met.** **This is tested by using a simulator.** **Method:** **Transmit the simulator signal over a suitable antenna.** **Adjust the signal power by use of a calibrated test receiver to –125 dBm ± 5 dBm.** **Replace the antenna of the calibrated test receiver by the receiving unit of the EUT.** **After the start of transmission and tracking with the nominal transmission level condition, gradually reduce transmission level down to –133 dBm.** **Required result:** **The EUT shall continue tracking at least one satellite.**		**Passed**
	5.6.9 **(4.3.8)**	**Effects of specific interfering signals**		
32	**5.6.9.1** **(4.3.8 a)**	**L Band Interference** **In a normal operating mode, using an appropriate signal source, the EUT shall be subjected to radiation of 3 W/m² at a frequency of 1 636.5 MHz for 10 min.** **The signal shall be removed and a successful performance check shall be carried out within 5 min.**	For test results see Annex B of this report	**Passed**
33	**5.6.9.2** **(4.3.8 b)**	**S Band Interference** **In a normal operating mode, using an appropriate signal source, the EUT shall be subjected to radiation consisting of a burst of 10 pulses, each 1.0 µs to 1.5 µs long on a duty cycle of 1600:1 at a frequency in the range of 2.9 GHz to 3.1 GHz at power density of approximately 7.5 kW/m². This condition shall be maintained for 10 min with the bursts of pulses repeated every 3 s.** **NOTE The peak power density is 7.5 kW/m² to be measured at the EUT, this is approximately 4.7 W/m² average power at a fixed transmitting antenna.** **The signal shall be removed and a successful performance check shall be carried out within 5 min.**		**Passed**

	5.6.10 (4.3.9)	**Position update**		
34	**5.6.10.1**	**Slow speed update rate** **The EUT shall be placed upon a platform, moving in approximately a straight line, at a speed of 5 knots ± 1 knot. The position output of the EUT shall be checked at intervals of 10 s, over a period of 10 min. The output position shall be observed to be updated on each occasion.** **This test may be carried out by using a simulator.**	**NOTE** The EUT was tested in a simulator (see Annex B)	**Passed**
35	**5.6.10.2**	**High speed update rate** **The EUT shall be placed upon a platform, moving in approximately a straight line, at a speed of 50 knots ± 5 knots. The position output of the EUT shall be checked at intervals of 1 s, over a period of 10 min. The output position shall be observed to be updated on each occasion.** **This test may be carried out by using a simulator with a speed of 70 knots at intervals of 0.5 s.** **The minimum resolution of position, i.e. latitude and longitude shall be checked by observation during 5.6.10.1 and 5.6.10.2 above.** **Record the IEC 61162 output of the EUT during this test and confirm that received positions at the end of each interval are in compliance with the real or simulated reference position.**	**NOTE** The EUT was tested in a simulator (see Annex B).	**Passed**
36	**5.6.11 (4.3.10)**	**Differential GPS input** **The manufacturer's documentation shall be inspected to:** **a) verify that the EUT will correctly process the message protocol of** **1) the RTCM recommended standards for differential NAVSTAR GPS service; or** **2) in the case where maritime radio beacons are used as the means of communication of the differential corrections, the standard contained in ITU-R M.823, and** **b) confirm that** **1) receipt of DGPS signals will be indicated;** **2) that the application of DGPS signals to the output ship's position is indicated; and** **3) the WER information is provided on an output port or at the display.**		**N/A**

	5.6.12 (4.3.11)	**Failure warnings and status indications**		
	5.6.12.1	**General alarm tests**		
37	**5.6.12.1.1 (4.3.11.1a 4.3.11.1b)**	**Position/HDOP alarm test** **Set up the EUT in a simulation environment with an HDOP <4. Select a specific EUT HDOP value as an indication threshold >4. Modify the simulator output until its HDOP is greater than the EUT specified HDOP threshold. Observe that an indication is given at the EUT within 5 s.** **Modify the simulator output until HDOP <4 and observe that the indication is removed.** **Switch off transmission of simulated signals and observe that the EUT releases an appropriate indication within 5 s.** **Verify that the last known position and ist time stamp are being displayed indicating the "loss of position" condition. Verify that this mode is provided constantly on display and output interface until removal of the error condition at the simulation environment.** **Switch on transmission of simulated signals and observe that the EUT resumes normal operation.**	**NOTE** EUT is an AIS, no indication of GPS status available	**N/A**
38	**5.6.12.1.2 (4.3.11.1c)**	**Differential GPS status indication test** **Set up the EUT in a simulation environment providing with an HDOP <4. Observe that the status of the EUT operation is GPD without using DGPS corrections.** **Set the EUT differential correction age mask to 30 s (if available).** **Start transmission of ITU-R M.823 differential corrections. Observe that the indication for DGPS status of EUT operation is given within 40 s.** **Stop transmission of ITU-R M.823 differential corrections. Observe that the status of EUT operation resumes to GPS without using DGPS corrections within 40 s**	**NOTE** EUT is an AIS class B, no differential mode available	**N/A**
	5.6.12.2 (4.3.11.2)	**Test of integrity monitoring using RAIM** **For the purpose of testing the RAIM functionality, it is recommended that means are provided for real-time display of the actual position error with reference to the simulated position.**	**NOTE** EUT is an AIS class B, no RAIM mode available, RAIM functionality tested by position output evaluation	**Passed**
39	**5.6.12.2.1**	**Testing of "safe" and "caution" status** **The EUT shall be set up under simulated conditions, providing 8 "healthy" satellites available, acquired and tracked.** **a) Select an accuracy level of 100 m.** **b) Observe that** **1) RAIM is indicated as "in operation", and**		**N/A**

		2) the "safe" status is indicated. **c) Consecutively reduce the number of "healthy" satellites until the "caution" state is raised.** **Observe that** **1) RAIM is still indicated as "in operation", and** **2) the status indication switched to "caution" within 10 s of the satellite change that caused it.** **d) Increase the number of "healthy" satellites until** **the RAIM state returns to "safe" state.** **Observe that** **1) RAIM is still indicated as "in operation", and** **2) the status indication switches to "safe" within** **2 min of the satellite change that prompted it.** **For each step of the above test sequence observe if the appropriate interface output is provided.** **Repeat the above test sequence for a selected accuracy level of 10 m and, if provided, for another accuracy level.**		
40	**5.6.12.2.2**	**Testing of "unsafe" status** **The EUT shall be set up under simulated conditions, providing 8 "healthy" satellites available, acquired and tracked.** **Select an accuracy level of 100 m.** **Observe that** **RAIM is indicated as "in operation", and** **The "safe" status is indicated.** **Change the behaviour of at least 1 satellite by varying the satellite clocks with the result that the position accuracy gradually degrades until it will no longer be inside the selected accuracy level with 95 % confidence level.** **Observe that RAIM is still indicated as "in operation", and the status indication switches to "unsafe" within 10 s if the actual position error exceeding the selected accuracy level.** **Change the behaviour of the satellites back to regular behaviour with the result that the position accuracy will be again inside of the selected accuracy level within 95 % confidence level.** **Observe that** **RAIM is still indicates as "in operation", and** **The status indication switches to "safe" within 2 min.** **For each step of the above test sequence observe if the appropriate interface output is provided.** **Repeat the above test sequence for a selected accuracy level of 10 m and, if provided, for another accuracy level.**		**N/A**

41	**5.6.13 (4.3.12)**	**Accuracy of COG and SOG** **Methods of test** **The EUT shall be set up on an appropriate mobile unit or simulator and all outputs indicating course over ground shall be monitored.** **At a constant forward direction, the forward speed shall be within 0 knots to 1 knot. Ten seconds after being in the range, measurements shall be made for a duration of 2 min. This cycle shall be repeated for all speed ranges of the Table 2 above.** **Required results** **The test results shall be observed on the display and the approved interface.** **For SOG tests, no reading of the speed indicator shall differ from the constant speed being applied at the time by more than 2 % of that speed or 0.2 knots, whichever is the greater.** **For COG tests, the differences between the reference direction and the measured course over ground in each test cycle shall not exceed the limits of Table 2.** **Validity of COG and SOG information** **The quality indicator of the GGA and VTG message of IEC 61162 shall be used for interpretation of validity of COG and SOG.** **Methods of testing** **Check of digital interface with IEC 61162. With the EUT normally operating, preclude invalid position data by reducing the number of received satellites. Investigate the content of the resultant GGA and VTG.** **Required result** **Observe that the quality indicator of GGA and VTG messages of IEC 61162 turn to invalid.** **Observe that the COG and SOG information contained in VTG message of IEC 61162 is replaced by null fields.**		**Passed**
42	**5.6.14 (4.3.12)**	**Output of UTC - Method of testing** **Check of digital interface with IEC 61162. While the EUT is navigating, provoke an invalid position by reducing the number of received satellites to two. Investigate the content of the GGA and ZDA messages provided.** **Required results** **Observe that the resolution of UTC information contained in the ZDA message is according to IEC 61162 requirements. Observe that the validity flag of GGA message of IEC 61162 turns to invalid.** **Observe that the ZDA message remains transmitted carrying complete UTC information.**		**N/A**

	5.7	**Typical interference conditions**		
	5.7.1	**Requirements**		
	5.7.1.1	**Typical interference conditions** **The GPS receiver equipment shall be capable of operating in typical interference condition. Operational situations include static accuracy and reacquisition within 30 s after satellite signals have been masked for 60 s or less by an obstruction, for example a bridge.** **Typical GPS interference effects can be characterised as being broadband noise-like interference, Continuous Wave Interference (CWI), or pulsed interference. Much work has been done in the aviation community to define interference levels in these three categories as reported in the Minimum Operational Performance Standards** **(MOPS) for Global Positioning System/Wide Area Augmentation System (GPS/WAAS) Airborne Equipment (RTCA/DO-229B October 6, 1999). The levels defined in this subclause are based upon the interference masks developed within RTCA. These masks are also described in ITU-R Recommendation M.1477.**	**NOTE** This test was performed by using a simulator (see Annex B).	**For results see test No. 43**
	5.7.1.2	**Broadband interference levels** **The interference mask for broadband noise-like interference varies as a function of the bandwidth of the interfering signal. This interference effect can be represented by broadband noise centred at 1575.42 MHz. The bandwidth dependent interference mask can be seen in Figure 1.**		**For results see test No. 43**
	5.7.1.3	**Continuous wave interference (CWI)** **Continuous wave interference interacts with the individual C/A code spectral lines found in the GPS signal structure. GPS receivers are typically more susceptible to CWI than to any other type of interference. The CWI mask can be seen in Figure 2.**		**For results see test No. 43**

	5.7.1.4	**Pulsed interference** **Pulsed interference can occur due to proximity to radars or other RF devices using pulsed waveforms. GPS receivers typically are fairly robust when exposed to low duty cycle pulsed interference. The interference mask for pulsed interference will consist of a pulse modulated carrier (CW) at 1575.42 MHz, with peak carrier level of –20 dBm and duty factor of 10 % while using a 1 ms pulse width.**		**For results see test No. 43**
	5.7.2	**Testing**		
	5.7.2.1	**The interference test procedures presented in this sub-clause follow closely the procedures used by aviation receiver manufacturers in the self-certification process used to show compliance with RTCA/DO-229B. The procedures have been adapted as necessary to meet the requirements of the IMO GPS requirements.**		**For results see test No. 43**
	5.7.2.2	**Simulator conditions** **The simulator conditions are as follows:** **five GPS satellites;** **one satellite at a maximum level of –120 dBm plus antenna gain at 90° elevation;** **one satellite at a minimum level of –130 dBm plus antenna gain at 5° elevation;** **three satellites at a level of –127 dBm plus antenna gain at 45° elevation.**		**For results see test No. 43**

	5.7.2.3	**Navigation solution accuracy test** **The normalised error associated with the navigation solution, which will be compared with the 10 m, 95 % horizontal accuracy requirement shall be computed using the formula shown below:** **$NE=[4(d_i)]/[HDOP_i]$** **where NE is the normalised error;** **d_i is the instantaneous 2-D horizontal position error (meters);** **$HDOP_i$ is the instantaneous horizontal dilution of precision.** **Scaling the instantaneous 2-dimensional position error (d_i) by $4/HDOP_i$ provides a means of normalising the tests to a constant HDOP = 4 and accounts for fluctuation in the satellite coverage due to changing geometry. $HDOP_i$ may be obtained from the receiver under test or calculated. Only those satellites used in the position solution shall be included in the $HDOP_i$ calculation.**		**For results see test No. 43**
	5.7.2.4	**Navigation solution accuracy test procedures**		
	5.7.2.4.1	**Interference conditions** **Interference conditions, including broadband noise centred at 1575.42 MHz, continuous wave interference (CWI), and pulsed interference shall be simulated. For the pulsed interference tests, a pulse-modulated carrier (CW)with peak carrier level of –20 dBm and duty factor of 10 % shall be used. The interference values are shown in the Three tables below.** **Broadband interference values** **Noise bandwidth: 1 MHz** **Total RMS power: -110.5 dBm** **Pulsed interference values** **Frequency: 1575.42 MHz** **Pulse width: 1 ms** **Continuous wave interference (CWI) values** **Frequency: 1575.42 MHz** **Power: -120.5 dBm** **Frequency: 1626.0 MHz** **Power: +8.0 dBm**		**For results see test No. 43**

	5.7.2.4.2	**Test procedures** **The EUT is subjected to one of the interference sources.** **The simulator scenario shall be engaged and the satellite signals turned on.** **The EUT shall be powered and initialised.** **While the EUT is providing position solutions, the interference shall be applied to the EUT, and the level of the interference shall be adjusted to the required value.** **When steady-state accuracy is reached, record a minimum of 100 position and HDOP values as reported by the EUT at a rate of one sample every 2 min.** **Repeat this cycle for any remaining interference source.**		**For results see test No. 43**
43	**5.7.2.4.3**	**Required results** **Pass/fail determination** **If the EUT reports a position with a normalised error greater than 10 m or fails to report a position in more than 5 % of the samples, a test failure is declared.**	(see Annex B)	**Passed**
	5.7.2.5	**Reacquisition test** **Method of test** **The reacquisition test is designed to simulate a temporary loss of signal, such as passing under a bridge. To determine the re-acquisition pass/fail criteria, consider a single trial where the EUT provides a valid position fix that is within required accuracy at 30 s from restoration of the satellite signals, and maintains a tracking status for at least the next 60 s. This unit is considered to have Passed one trial.**		**For results see test No. 44**
	5.7.2.5.1	**Re-acquisition test procedures**		
	5.7.2.5.2	**Interference conditions** **The interference condition to be tested is shown below. This is a broadband noise value centred at 1575.42 MHz.** **Noise bandwidth: 1 MHz** **Total RMS power: -110.5 dBm**		**For results see test No. 44**

	5.7.2.6	**Re-acquisition scenarios**		
	5.7.2.6.1	**Test procedures** **The EUT is subjected to the broadband interference source.** **The simulator scenario shall be engaged and the satellite signals turned on.** **The EUT shall be powered and initialised.** **The EUT shall be allowed to reach steady-state accuracy before the satellites are to be switched off.** **The simulator RF output shall be removed for 30 S.** **The simulator RF output shall be restored to the EUT.** **After 30 s record a position and HDOP value as reported by the EUT. If after 30 s, no position report has been sent from the receiver, record a trial failure and go to step i).** **Ensure that the receiver continues position reporting for the next 60 s.** **Go to step d) and repeat as required (note that if the simulator scenario is reset, some receiver may require purging of all previous data to enable proper operation. This is due to the persistence of time data in the receiver and the inability of the receiver's software to deal with a backward transition in time).**		**For results see test No. 44**
44	**5.7.2.6.2**	**Required results** **Pass/fail criteria** **A failure by the EUT to provide a position output after 30 s, reporting a position with normalised error greater than 10 m, or failing to continue position reporting for 60 s after sampling indicated a failure mode, and results in declaring a trial failure. To determine the reacquisition time pass/fail criteria, the test disposition table shall be used.**	(see Annex B)	**Passed**
45	**5.8**	**Performance checks under IEC 60945 conditions** **Environmental requirements of IEC 60945 appropriate to its category, i.e. "protected" and "exposed", shall be carried out. The manufacturer shall declare any pre-conditioning required before environmental checks.** **Performance checks shall be performed for** **initial (cold) start;** **acquisition;** **tracking (navigation)**	**NOTE** For marine equipment environmental testing has to be carried out for granted type approval. 60945 testing is not part of this testreport. See 60945 test for EUT.	**N/T**

Annex A - Test equipment

A.1 Test equipment summary

Model / Program	*Serial No. / Version No.*	*Calibrated / Function test*	*Used for*
Reference position roof of BSH building		Lat: 53° 32.8136481666' Lon:9° 58. 1016981666'	L- and S-Band interference
GPS Simulation Unit	SPIRENT Communications Hardware:Typ: GSS8000, S/N: 8629 Software: SimGEN Ver. 2.7	Calibration date 2009/12/14 Function tests performed successfully according documented test procedures before performance of tests	All GPS testing, unless stated otherwise
MiniCircuits RF- Amplifier	ZHL-5W-2G-S+	Function tests performed successfully	L-Band interference
Radar-Device Furuno FR 2135S	FR-2105 Series	N/A	S-Band interference
Signal Generator R&S SMJ100	S/N: 100858	2007/10/15	Interference tests IEC 61108-1 Ed.2, §5.6.9.1; §5.7
Power sensor R&S Smart Sensor NRP-Z81	S/N: 100140	2007/08/27	Calibration of GPS measurement inside RF-chamber
Narda Broadband Field Meter	B-1059/NBM550	Calibrated	Induced Power of L/S-Band
Horn Antenna Schwarzbeck BBHA 9120A	BBHA 9120A 535	2009/11/26	Calibration of GPS measurement inside RF-chamber

Reference position

Made by FREIE UND HANSESTADT HAMBURG
Vermessungsamt –VA311-

Description of point	geocentrically co-ordinates (WGS84)		geodetical geographical co-ordinates (WGS84)		Gauß-Krüger (Bessel)	
North	x(m)	3740601.680	N	53° 32' 49''.49049	x(m)	5935502.790
	y(m)	657439.492	E	9° 58' 6''.10408	y(m)	3 564257.804
	z(m)	5107029.673	Height over Ellipsoid	95.900 m	Altitude above sea level	55.969 m
South	x(m)	3740618.106	N	53° 32' 48''.81889	x(m)	5935482.027
	y(m)	657442.338	E	9° 58' 6''.10189	y(m)	3 564258.046
	z(m)	5107017.296	Height over Ellipsoid	95.849 m	Altitude above sea level	55.917

Accuracy of survey = 0.02 m - last survey dated 2009-05-04

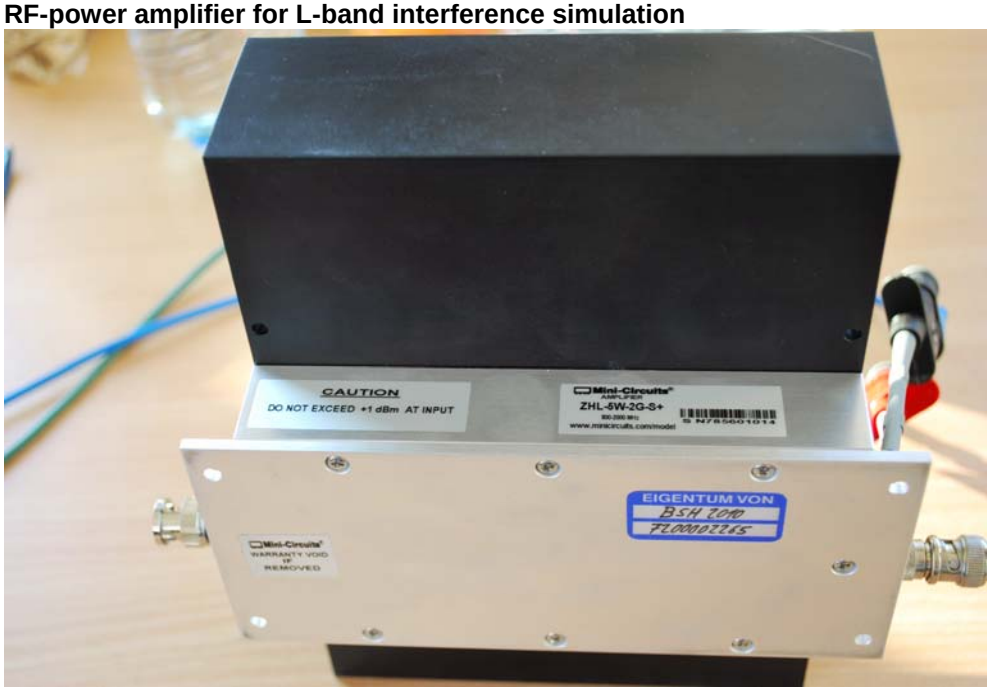
A.2 Documentation of test equipment

A.2.1 Simulation of ±22° roll

Angular movement of antenna – Motor driven device

A.2.2 L-band interference signal amplifier

RF-power amplifier for L-band interference simulation



Horn antenna and Narda Field Meter for L-band interference simulation

A.2.3 Radar device

Specification of RADAR used for S-Band Test

Manufacturer:	**Furuno Electric Co., LTD.**
Model:	**FR-2105 Series**
Specifications:	
Antenna radiator:	
Type:	**Slotted waveguide array**
Bandwidth:	**S-Band**
Radiator Type:	**SN7AF**
Length:	**12 ft**
Beamwidth (H):	**1.9°**
Beamwidth (V)	**20°**
Sidelobes ±10°:	**-28 dB**
Polarization:	**Horizontal**
RF Transceiver:	
Frequency:	**X-Band, 3050 MHz ± 30 MHz**
Output power:	**FR-2135S/SW: 35 KW**

Pulse lengths and PRR (<RF aloft>)

Range scales	P/L (µs)	PRR (Hz)
0.125 / 0.25	0.07	3000
0.5	0.07 / 0.15	3000
0.75 / 1.5	2 from 0.07 / 0.15 / 0.3	3000 / 1500
3	2 from 0.15 / 0.3 / 0.5 / 0.7	3000 / 1500
6	2 from 0.3 / 0.5 / 0.7 / 1.2	1500 / 1500
12 / 24	2 from 0.5 / 0.7 / 1.2	1000 / 600
48 / 96	1.2	600

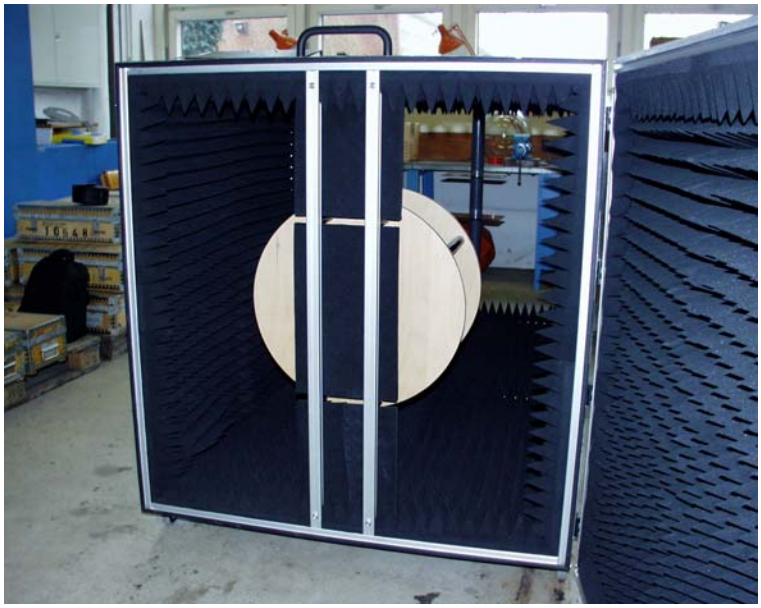
A.2.4 GPS Simulation

GPS/ Galileo Simulation at BSH

Arrangement of GPS- and noise/ interference transmitting antennas

GPS test box, exterior view

GPS test box, interior view



A.2.5 Calibration protocol of RF- Chamber

Calibration protocol								
Date	21.10.2010							
Test eng.	Ehlers							
Place of Test	BSH Room 042							
Equipment								
R&S SMJ100A Signalgenerator								
Helixantenna H1116R6								
Schwarzbeck BBHA 9120 Hornantenna								
GPS- transmitting antenna 2G1216P - Antcom Corp.								
Agilent spectral analyser								
Spirent GSS8000								
Pdef.	-130	dBm	ICD GPS200 defines -130dBm as minimum received power at 3dBi antenna					
Ins. loss RF-box	36,6	dB		IEC61108-1:2003 defines -125dBm				
Ptrans	-50	dBm	Input power of transmitting antenna					
G trans. Ant.	5	dBi	Gain of GPS- transmitting antenna					
Prec.	-78	dBm	received power					
Grec.ant.	9	dBi	Gain of calibrated Schwarzbeck BBHA 9120 @ 1575MHz					
Ppol.loss	3,4	dB	Polarization loss					
cabel	2	dB	Cable loss transmitting antenna					
cabel	2	dB	Cable loss receiving antenna					
Ptrans GPS	-66	dBm	GPS Simulator RF- power					
Attenuation	**30,4**	**dB**	attenuation needed for adjusted power level					

Calibration of interference							
Date	21.10.2010						
Test eng.	Ehlers						
Equipment							
R&S SMJ100A Signal generator							
Helical antenna H1116R6							
GPS- transmitting antenna 2G1216P - Antcom Corp.							
Agilent Spektrumanalysator							
Spirent GSS8000							
Noise 1MHz -110,5dBm							
Pdef.	-110,5	dBm	Needed interference power				
Ins. loss RF-I	36,6	dB					
Ptrans	-80,9	dBm	Needed power at interference trans. Antenna				
G trans. Ant.	7	dBi	Gain of interference trans. ant.				
cable loss	1,5	dB					
Power adj.	**-79,4**	**dB**	needed power level at SMJ100A				
Pulsed -20dBm							
Pdef.	-20	dBm	Needed interference power				
Ins. loss RF-I	36,6	dB					
Ptrans	9,6	dBm	Needed power at interference trans. Antenna				
G trans. Ant.	7	dBi	Gain of interference trans. ant.				
cable loss	1,5	dB					
Power adj.	**11,1**	**dBm**	needed power level at SMJ100A				

CW @ 1575,42; -120,5dBm							
Pdef.	-120,5	dBm	Needed interference power				
Ins. loss RF-	36,6	dB					
Ptrans	-90,9	dBm	Needed power at interference trans. Antenna				
G trans. Ant.	7	dBi	Gain of interference trans. ant.				
cable loss	1,5	dB					
Power adj.	**-89,4**	**dBm**	needed power level at SMJ100A				
CW @ 1626,0; +8,0dBm		alternativ CW@1596,0MHz; -80dBm					
Pdef.	-80	dBm	Needed interference power				
Ins. loss RF-	36,6	dB					
Ptrans	-50,4	dBm	Needed power at interference trans. Antenna				
G trans. Ant.	7	dBi	Gain of interference trans. ant.				
cable loss	1,5	dB					
Power adj.	**-48,9**	**dBm**	needed power level at SMJ100A				

Annex B - Test diagrams

B.1 § 5.6.4.1Static accuracy

B.1.1 § 5.6.4.1.1 Static accuracy – GPS

Position fix measurements shall be taken over a period of not <24 h. The absolute horizontal position accuracy shall be within 13 m (95 %), having discarded measurements taken in conditions of HDOP ≥ 4 and PDOP ≥ 6.

Conditions of tests performed – Real GPS signal

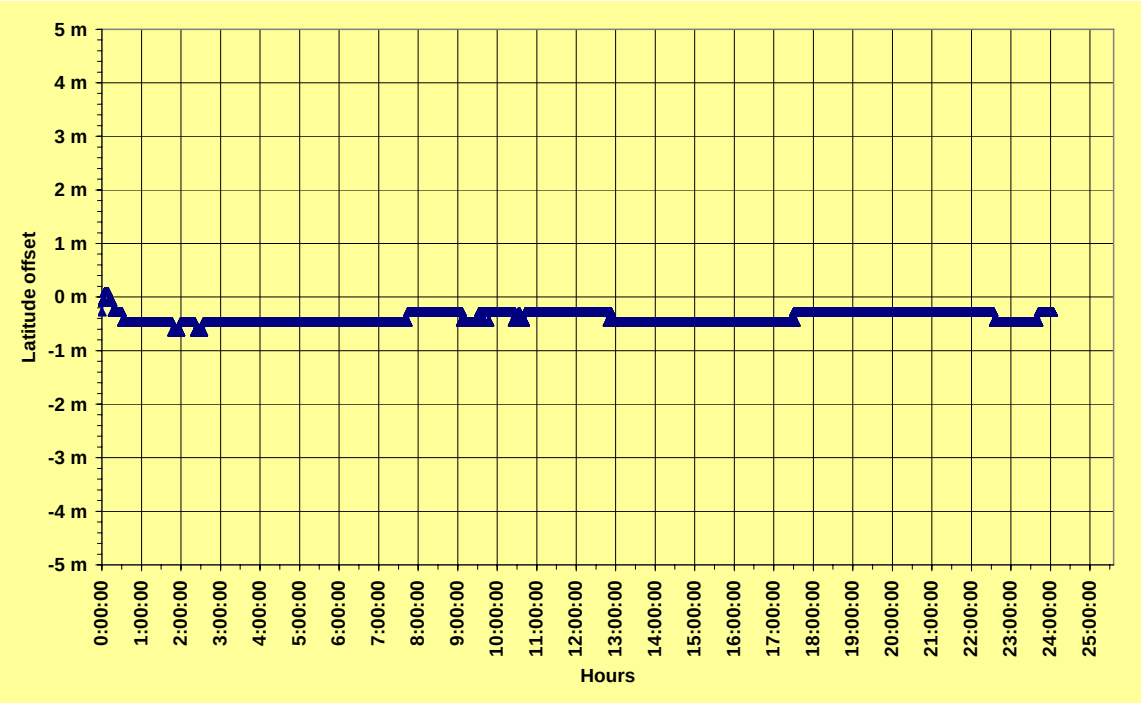
Period of position fix measurements:	~24 h
Position fix measurements :	>87000
Accuracy:	HDOP ≤ 4 (or PDOP ≤ 6)

Test results
All deviations of measured positions from reference position are <±13 m (95 %).
2 sigma value of position data: 0.96m.

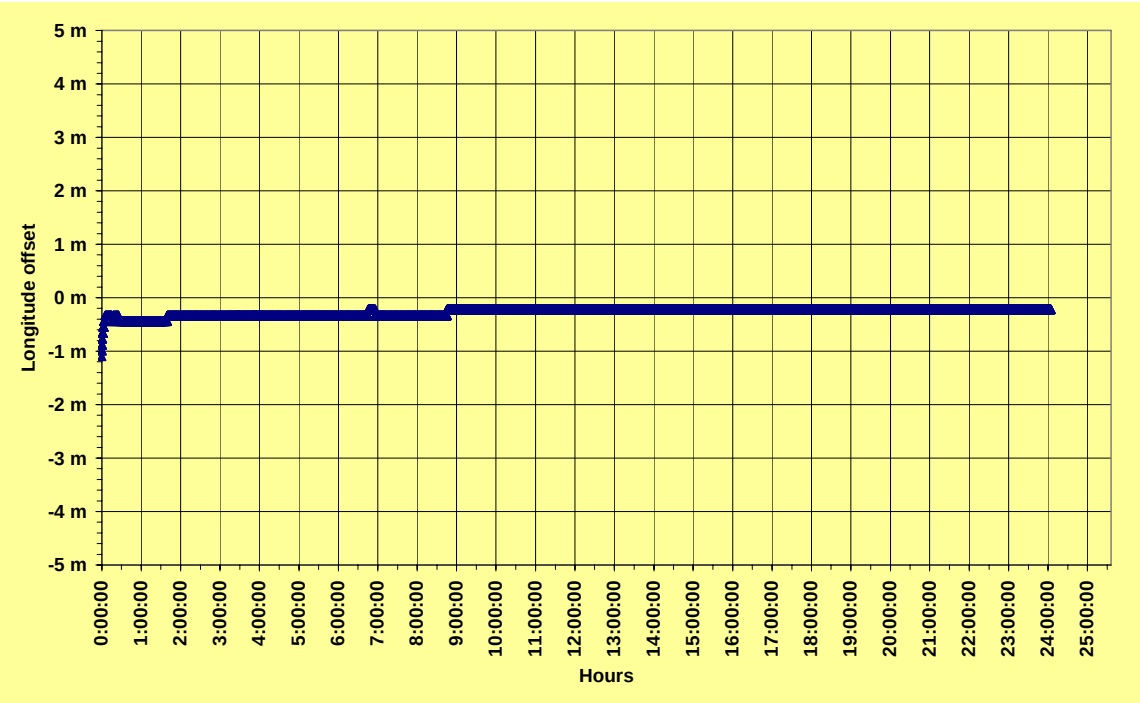
Test result: Passed

For details of validation of recorded data see the following pages.

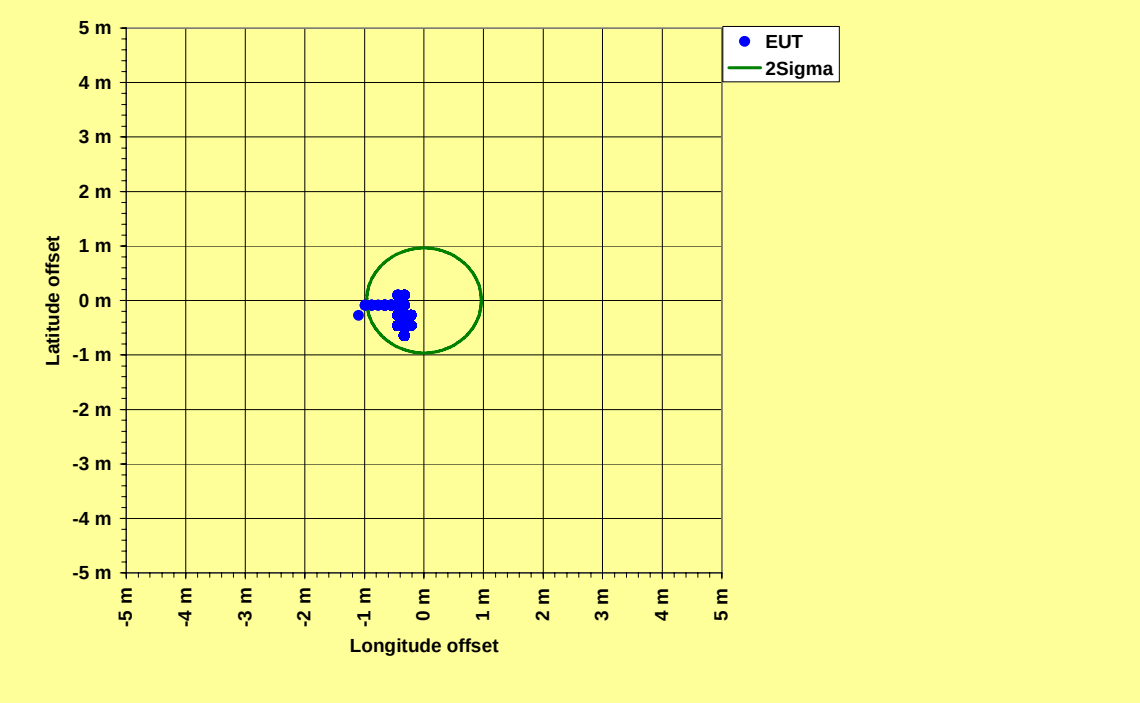
Latitude offset – GPS static accuracy



Longitude offset – GPS static accuracy



Position offset – GPS static accuracy



B.2 § 5.6.4.2 Angular movement of the antenna

B.2.1 § 5.6.4.2 Angular movement of the antenna – GPS

The static test(s) specified in 5.6.4.1.1 (and 5.6.4.1.2) shall be repeated with the antenna performing an angular displacement of ± 22.5 ° (simulating roll) in a period of about 8 s during the duration of the test.

Conditions of tests performed – Real GPS signal

Antenna placed on a motor-driven socket simulating the angular displacement required for the test.

Period of position fix measurements:	~ 24 h
Position fix measurements :	~84600
Accuracy:	HDOP ≤ 4 (or PDOP ≤ 6)

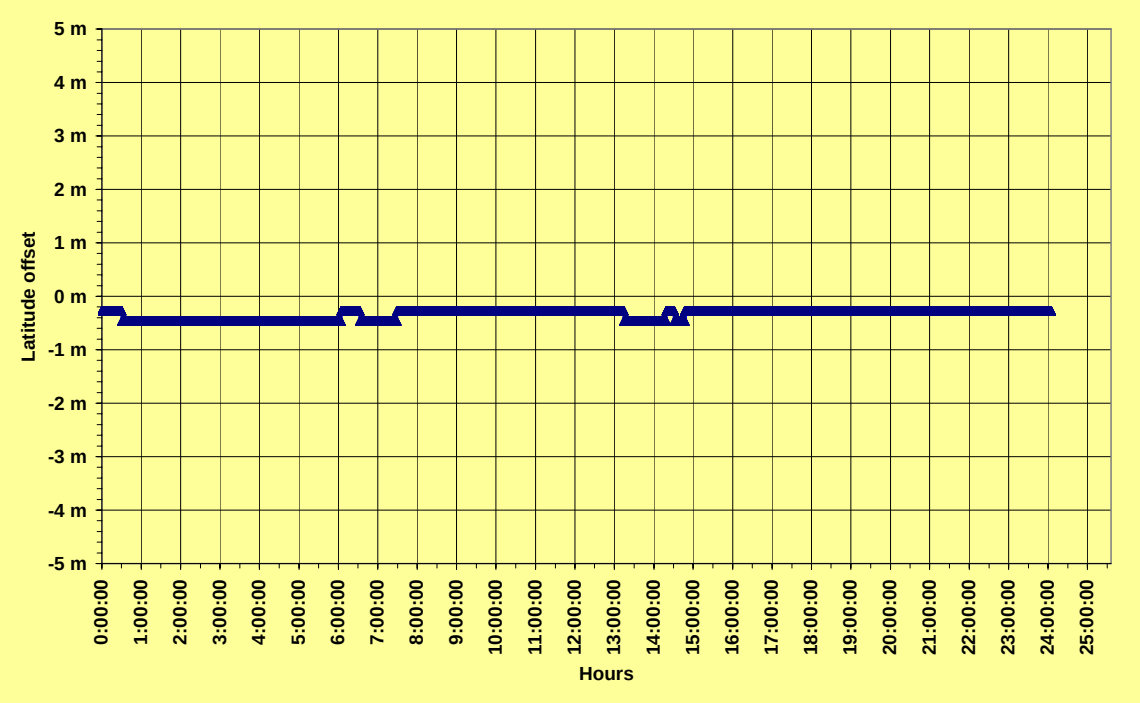
Test results for § 5.6.4.2.1

All deviations of measured positions from reference position
are <±13 m (95 %).
2 sigma value of position data: 0.83m.

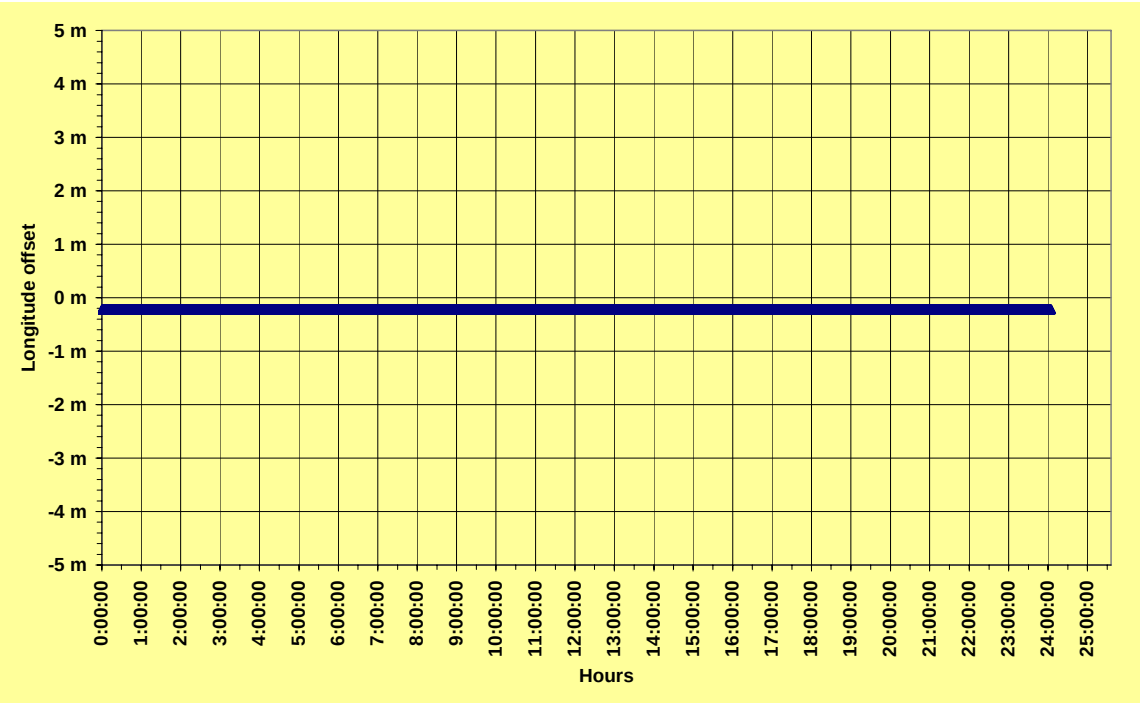
Test result: Passed

For details of validation of recorded data see the following pages.

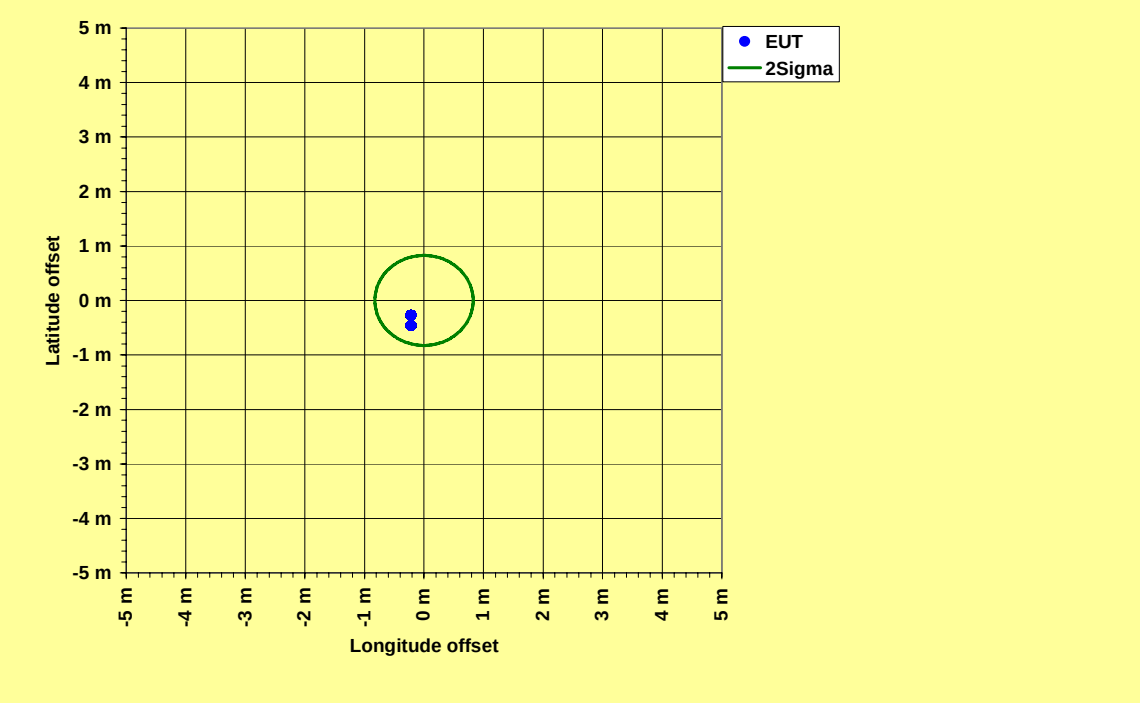
Latitude offset – Angular movement of antenna, GPS



Longitude offset – Angular movement of antenna, GPS



Position offset – Angular movement of antenna, GPS



B.3 § 5.6.4.3 Dynamic accuracy

B.3.1 § 5.6.4.3.1 GPS part a)

A fully locked and settled EUT travelling in a straight line at 48 kn ± 2 kn for a minimum of 1.2 min which is reduced to 0 kn in the same straight line in 5 s, shall not indicate a position offset ± 13 m from the final position 10 s after coming to rest.

Conditions of tests performed

Tests performed using a simulator

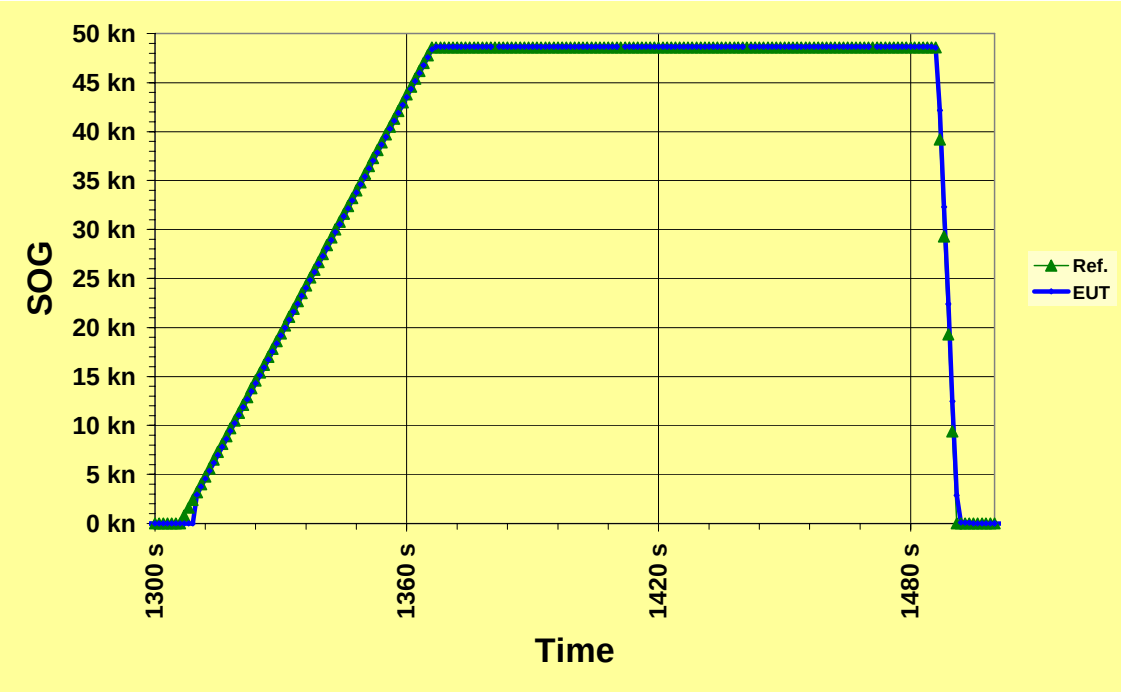
Test results

All positions offsets are <± 13 m.

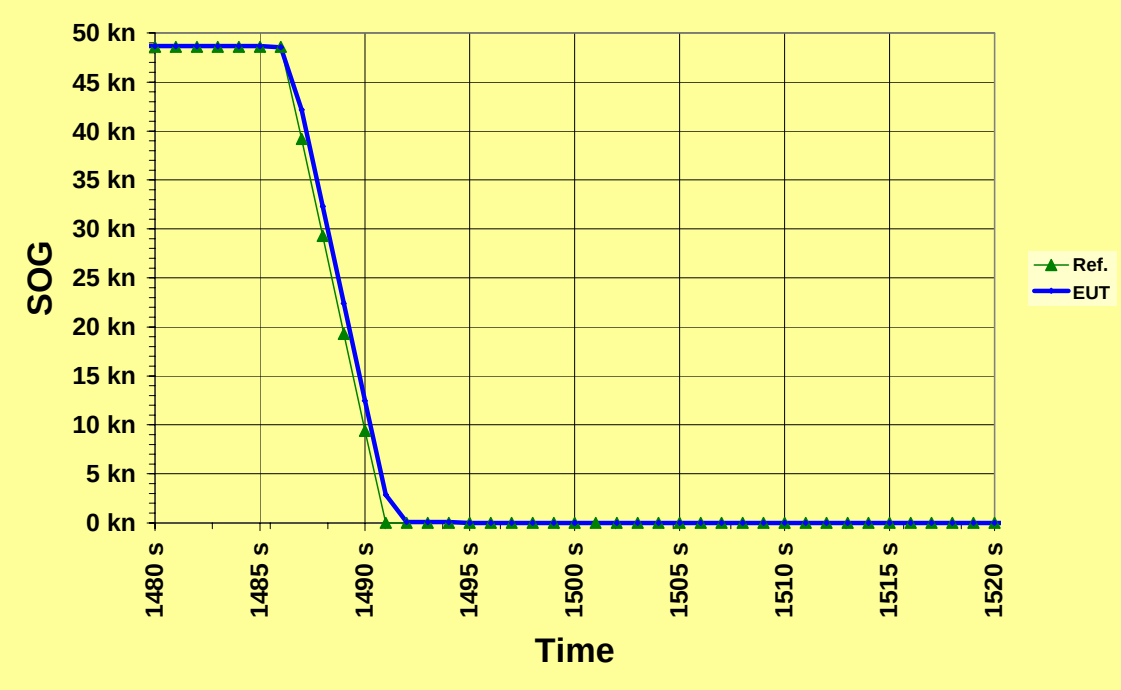
Test result: Passed

For details of validation of recorded data see the following pages.

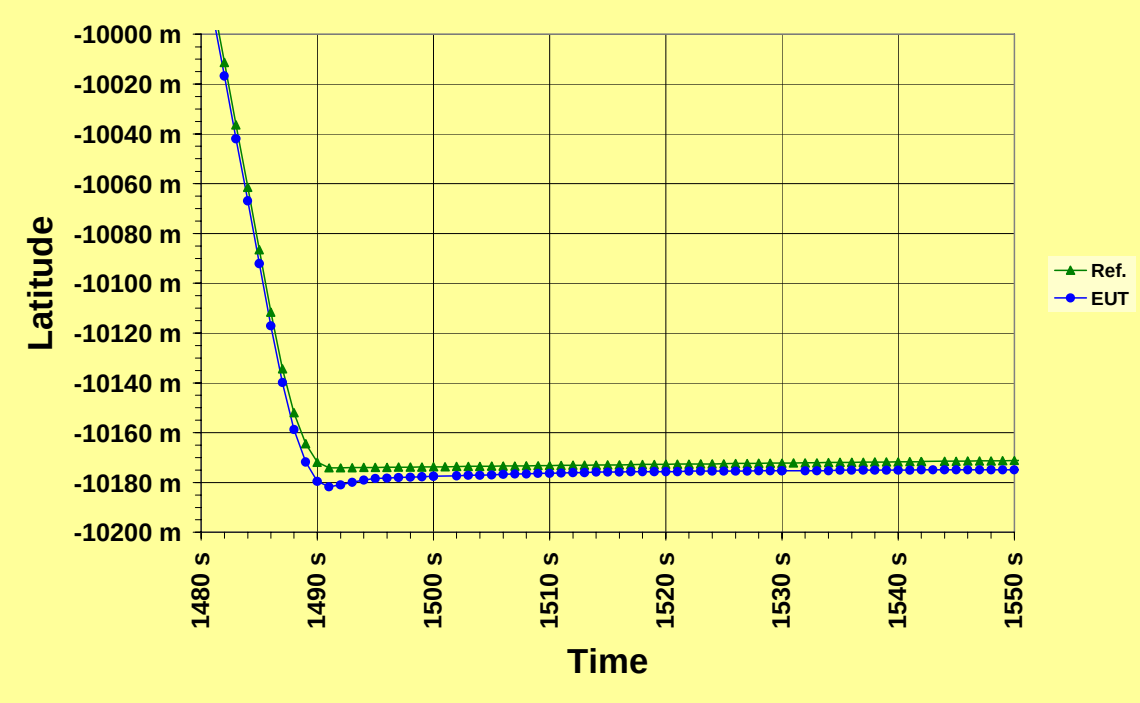
Speed over ground (SOG)



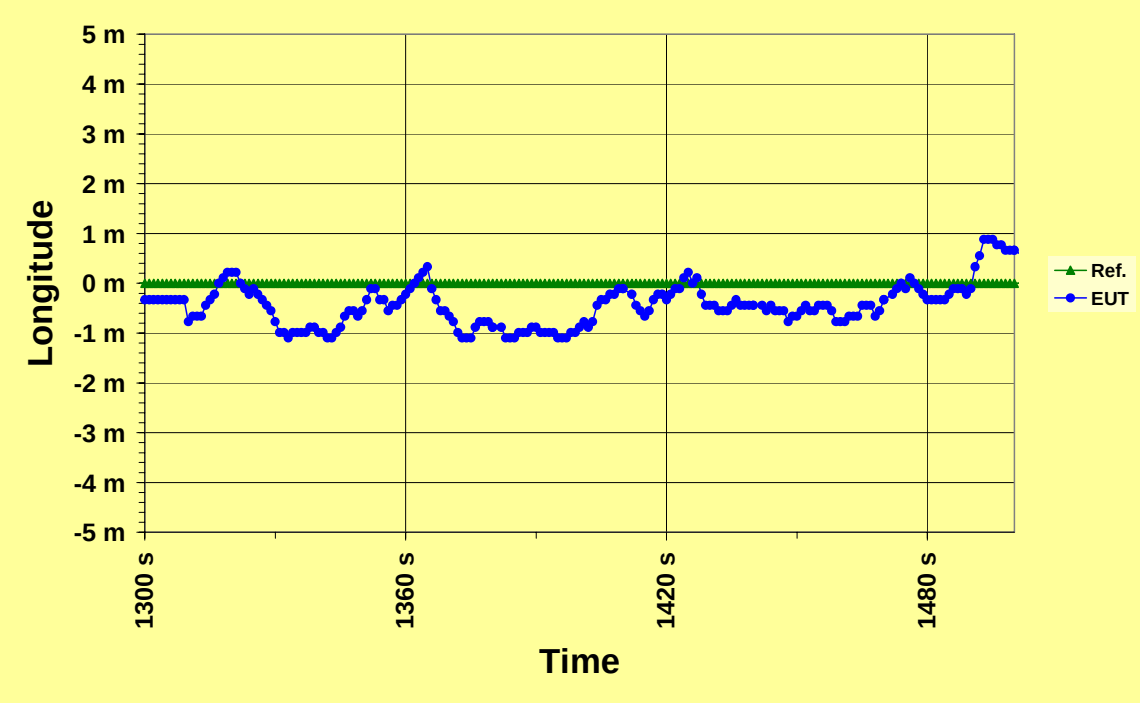
Speed over ground, coming to rest position



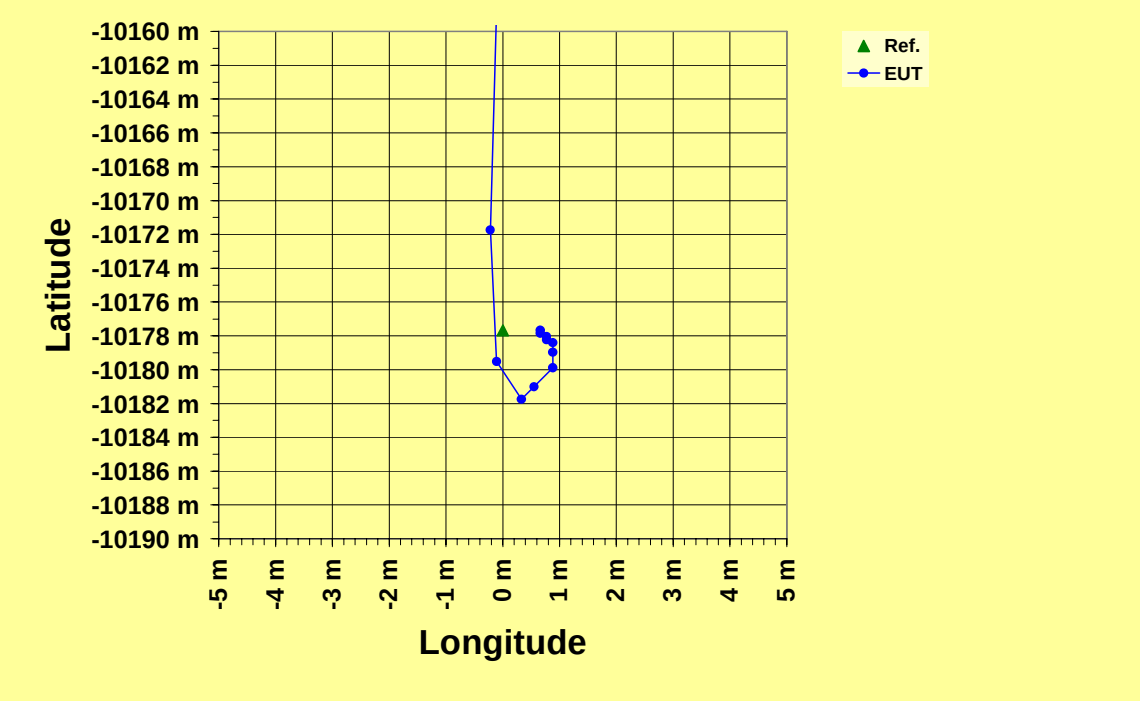
Latitude, coming to rest position



Longitude



Position



B.3.2 § 5.6.4.3.1 GPS part b)

A fully locked and settled EUT travelling at least 100 m at 24 kn ± 1 kn in a straight line then subjected, for at least 2 min, to smooth deviations either side of the straight line of approximately 2 m at a period of 11 s to 12 s shall remain in lock and follow the actual position to within a lane of 30 m wide centred on the mean direction of motion.

Conditions of tests performed

Tests performed using a simulator

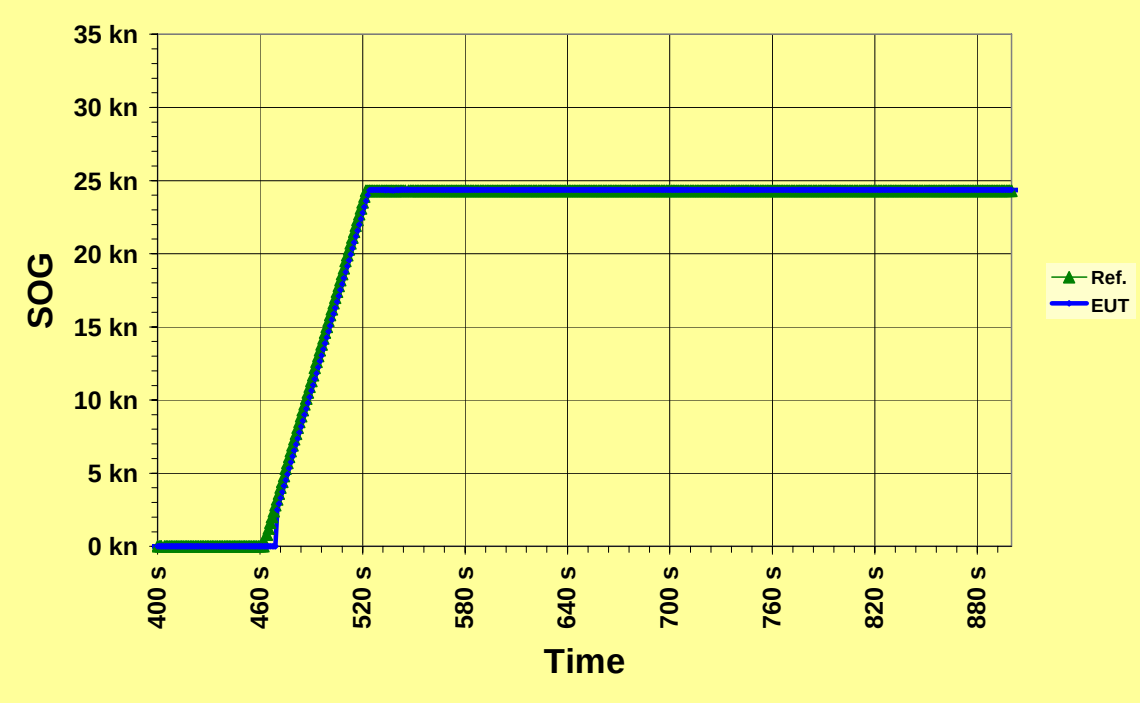
Test results

All positions offsets are within a lane of 30 m.

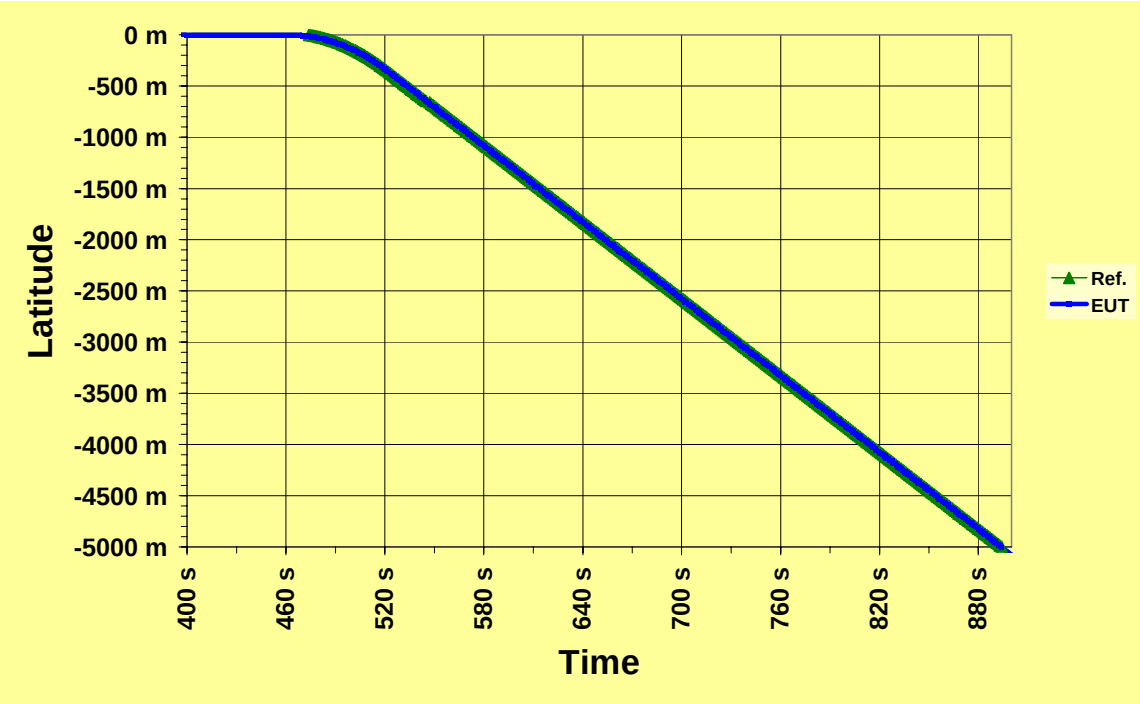
Test result: Passed

For details of validation of recorded data see the following pages.

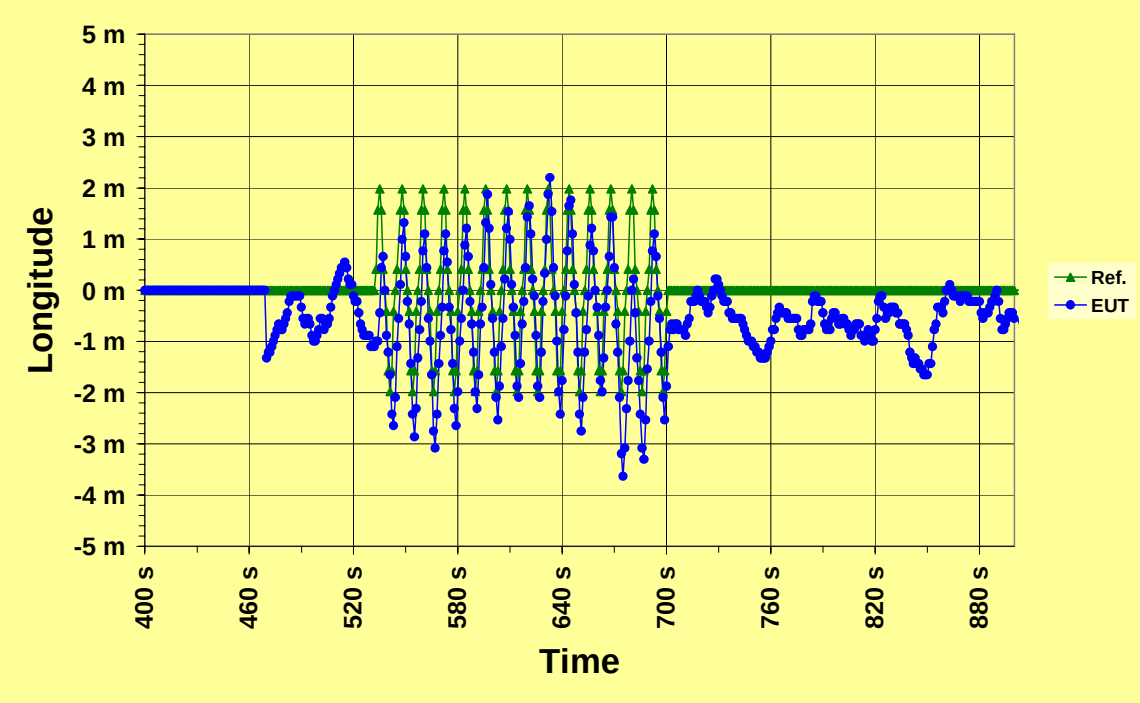
Speed over ground (SOG) vs. time



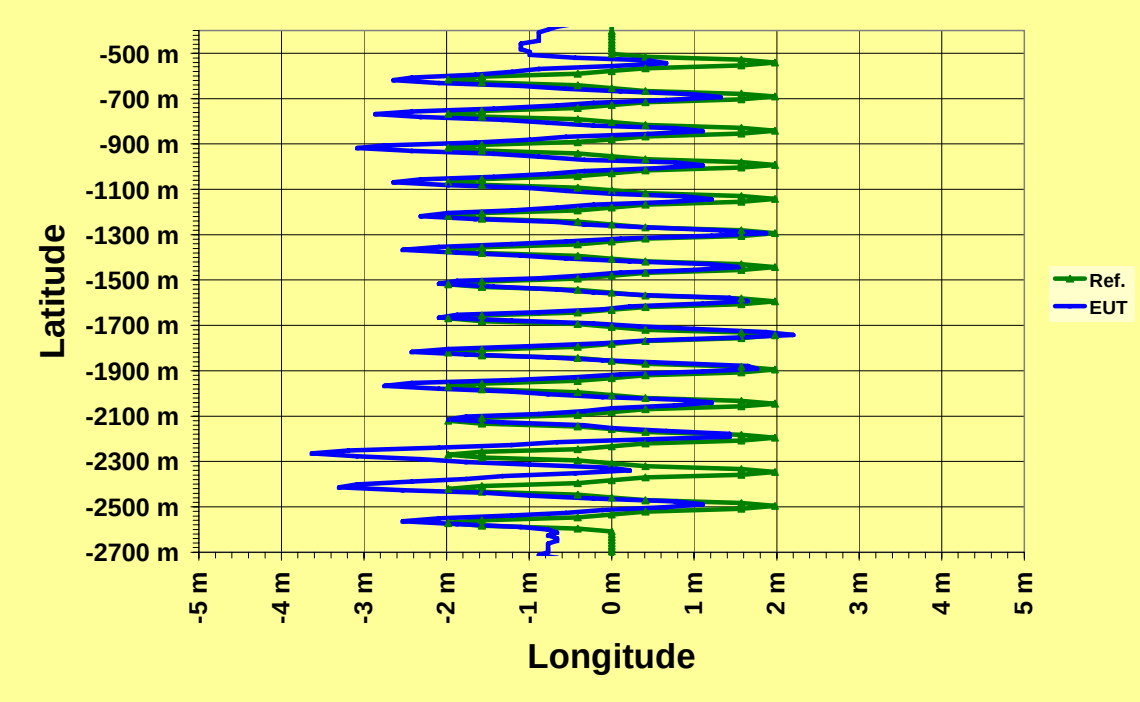
Latitude vs. time



Longitude vs. time



Position



B.4 § 5.6.5 Aquisition

B.4.1 § 5.6.5.1 Condition A - Initialization

EUT shall be powered on without valid almanach data in memory.
A performence check shall be carried out after 30 minutes of operation.

Conditions of test performed

EUT was powered for use with the simulator → No valid almanach data for simulated satellite constellation available.

EUT locked on to GPS simulation within less than 30 minutes and provided a valid positon fix. A performance check was carried out. See Annex B.4.2

Test result: Passed

B.4.2 § 5.6.5.2 Condition B – Power Outage

EUT shall be isolated from power source for 24 to 25 hours.
A performence check shall be carried out after 5 minutes of operation.

Conditions of test performed

EUT was isolated from power for approx. 24.5 hours.

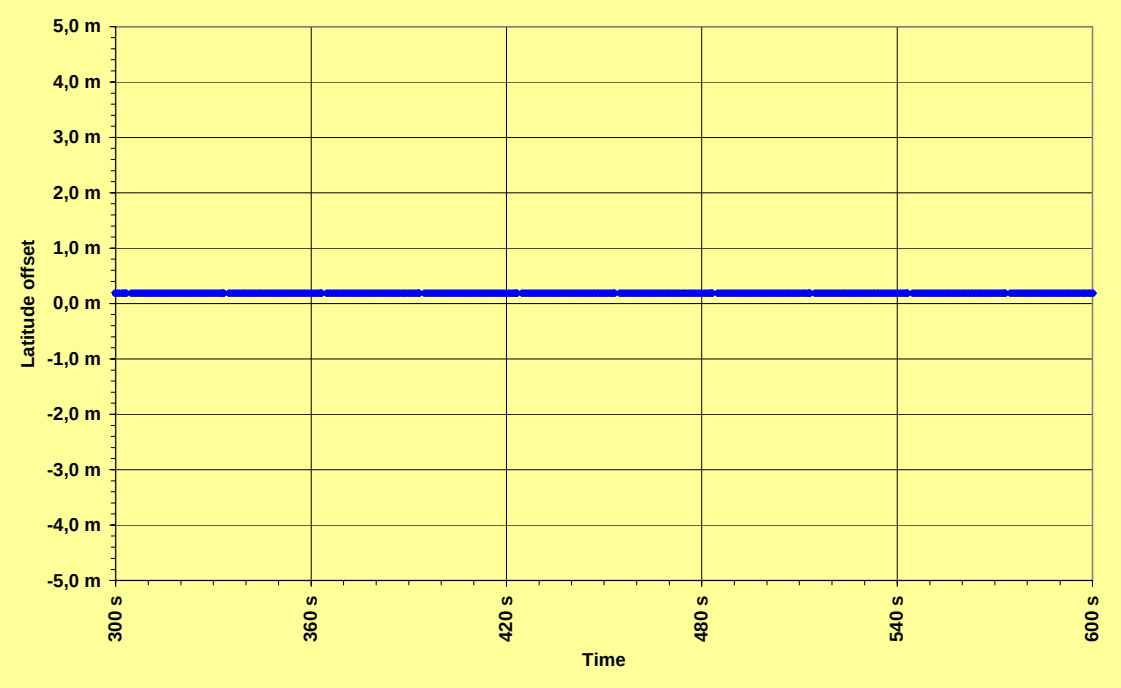
EUT locked on to GPS simulation within less than two minutes and provided a valid positon fix. A performance check was carried out after 5 minutes of operation.

2 Sigma value of performence check: 0.64m

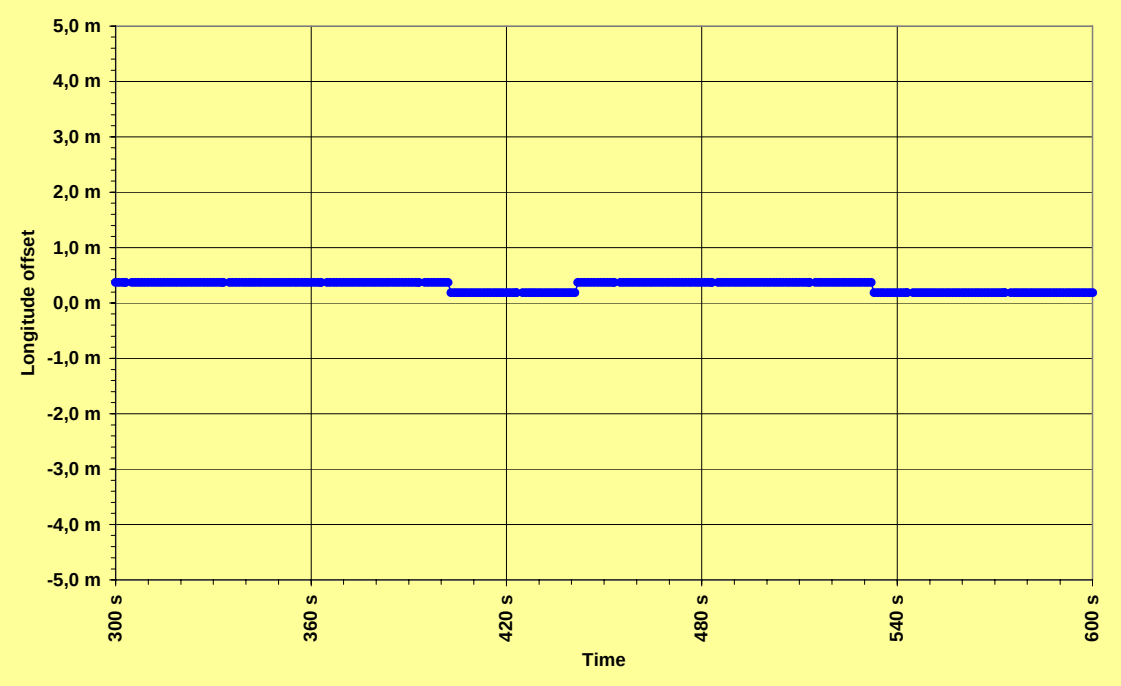
Test result: Passed

For details of validation of recorded data see the following pages.

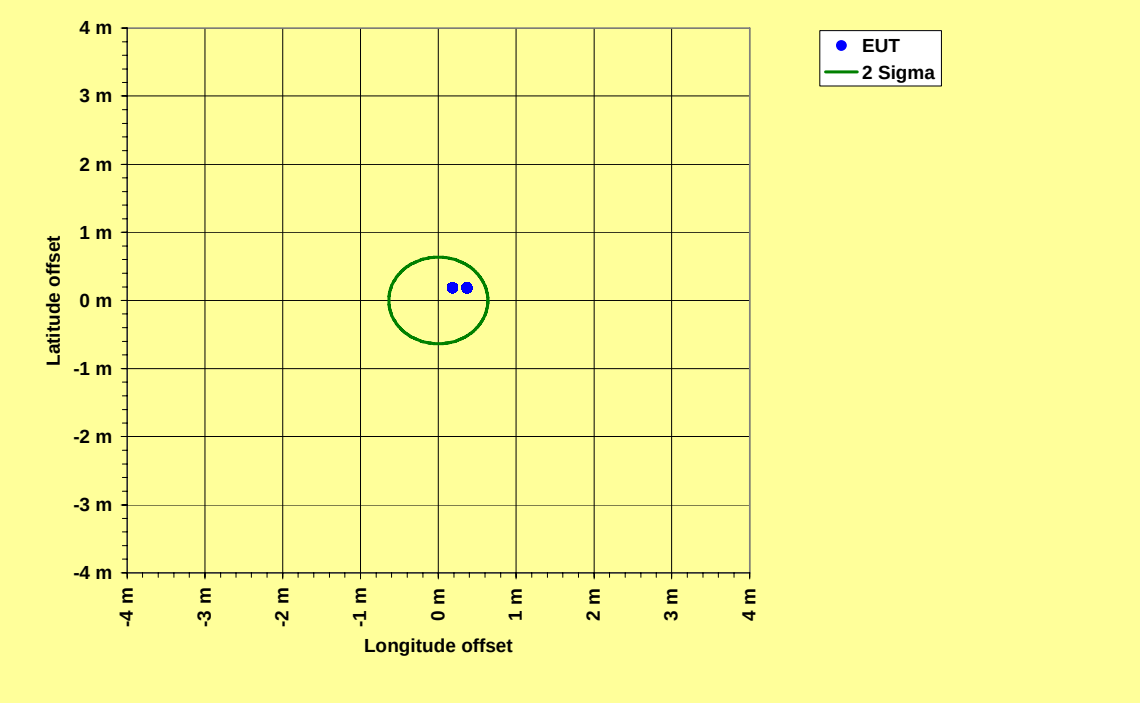
Latitude offset after 5 minutes operation



Longitude offset after 5 minutes of operation



Position offset after 5 minutes of operation



B.4.3 § 5.6.5.3 Condition C – Interruption of GPS signal

EUT antenna shall be completely masked for 24 to 25 hours.
A performence check shall be carried out after 5 minutes of operation.

Conditions of test performed

EUT antenna was masked for approx. 24.5 hours.

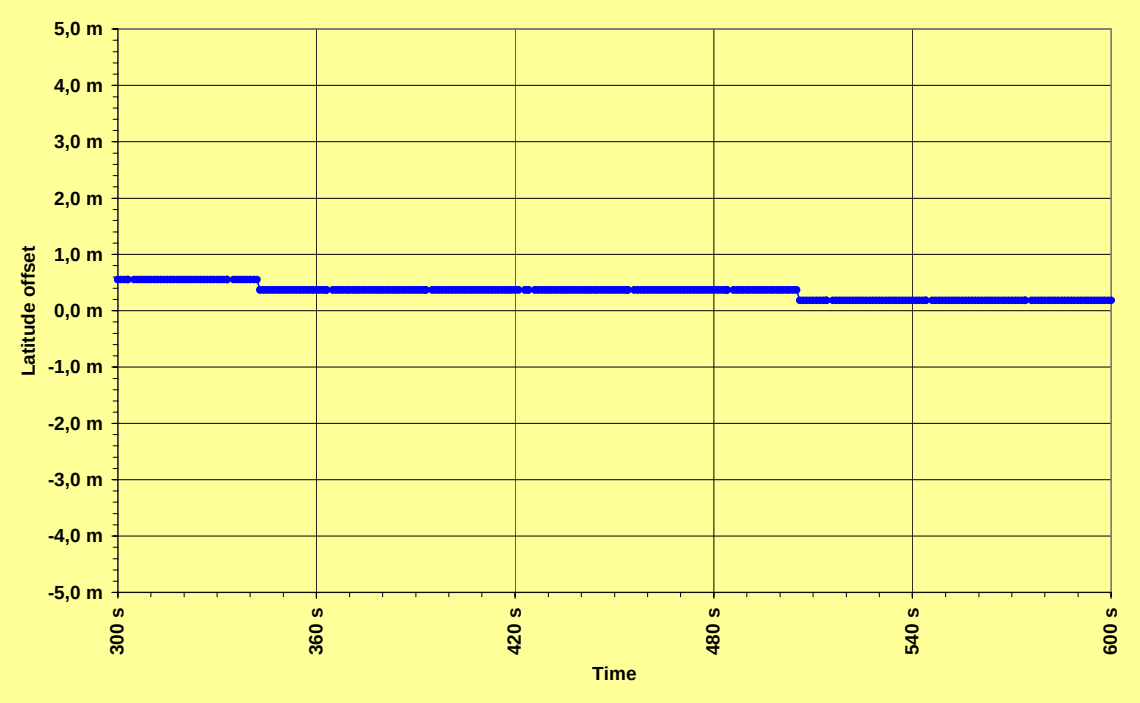
EUT locked on to GPS SIMULATION within less than two minutes and provided a valid positon fix. A performance check was carried out after 5 minutes of operation.

2 Sigma value of performence check:1.34m

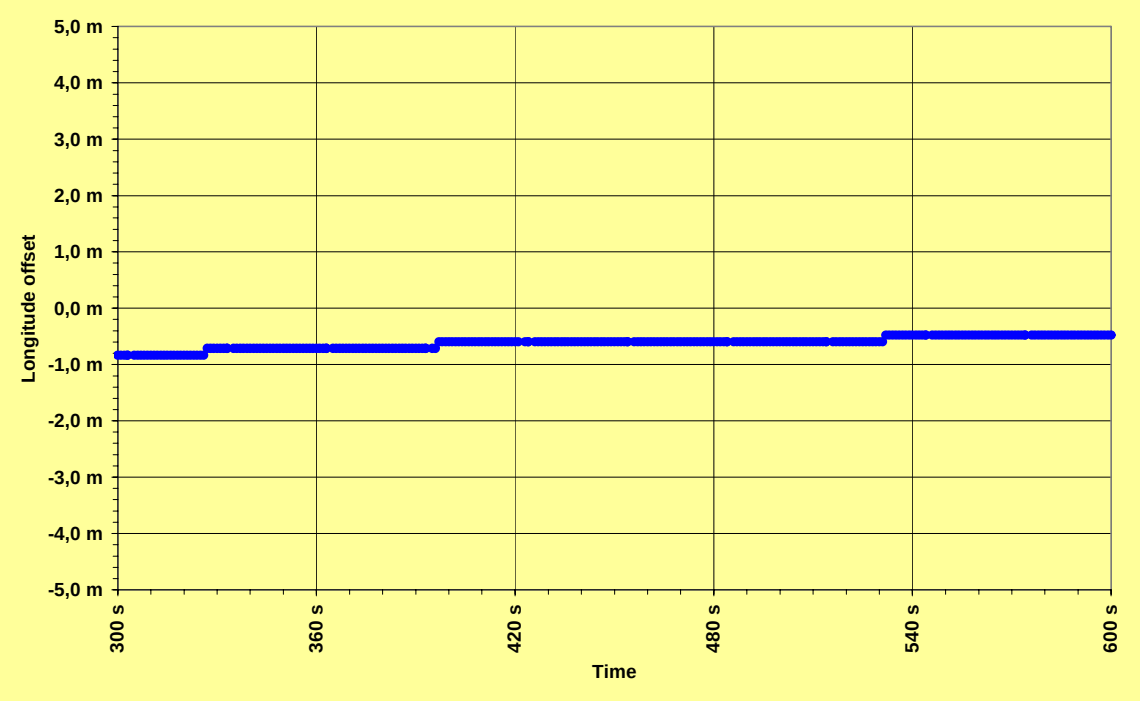
Test result: Passed

For details of validation of recorded data see the following pages.

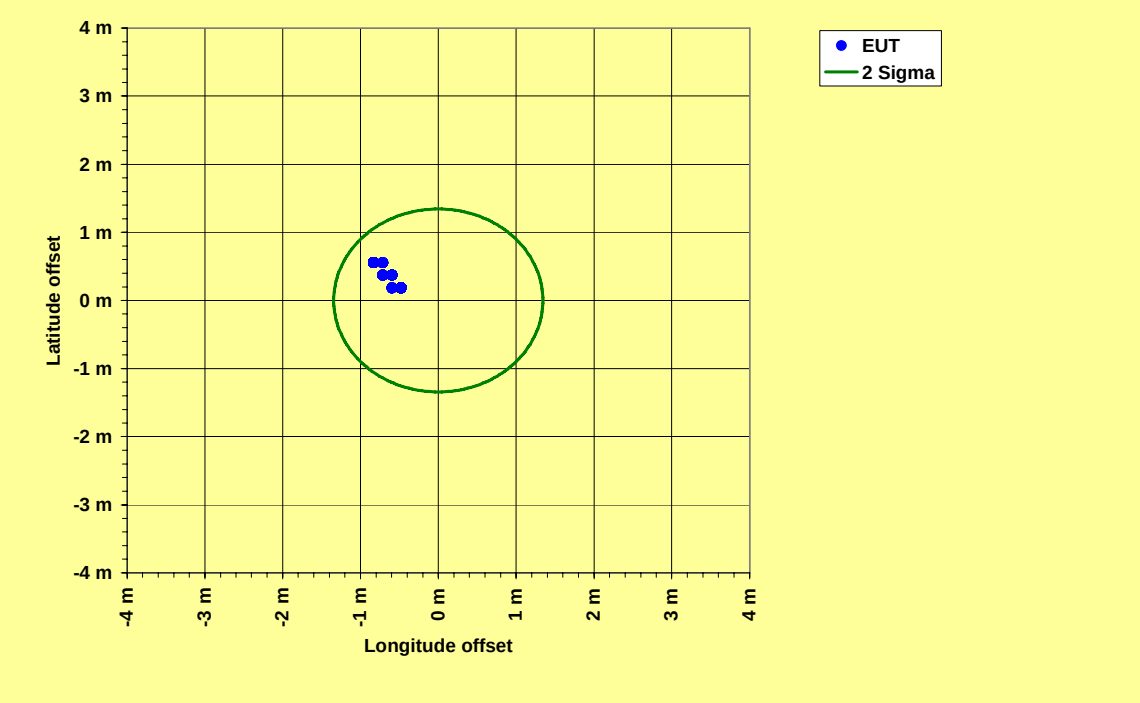
Latitude offset after 5 minutes operation



Longitude offset after 5 minutes of operation



Position offset after 5 minutes of operation



B.4.4 § 5.6.5.4 Condition D – Brief interruption of power

EUT shall be isolated from power for 60s.
A performence check shall be carried out after 2 minutes of operation.

Conditions of test performed

EUT was isolated from power for 60s.

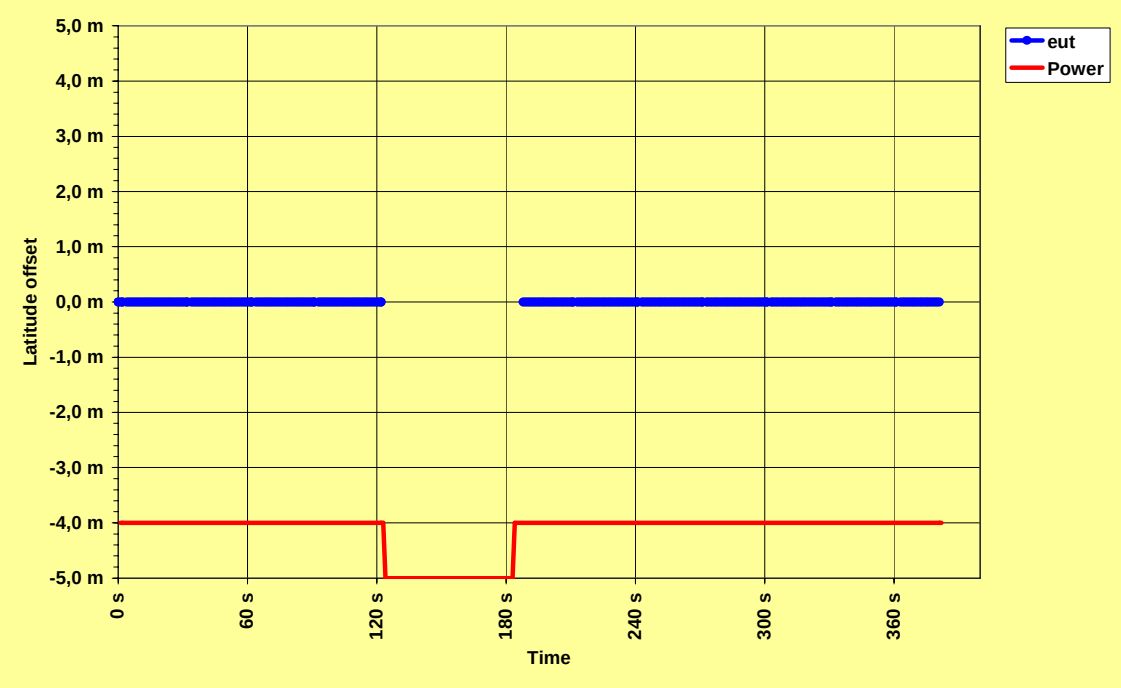
EUT locked on to GPS simulation within less than two minutes and provided a valid positon fix. A performance check was carried out after 2 minutes of operation.

2 Sigma value of performence check: 1.12m

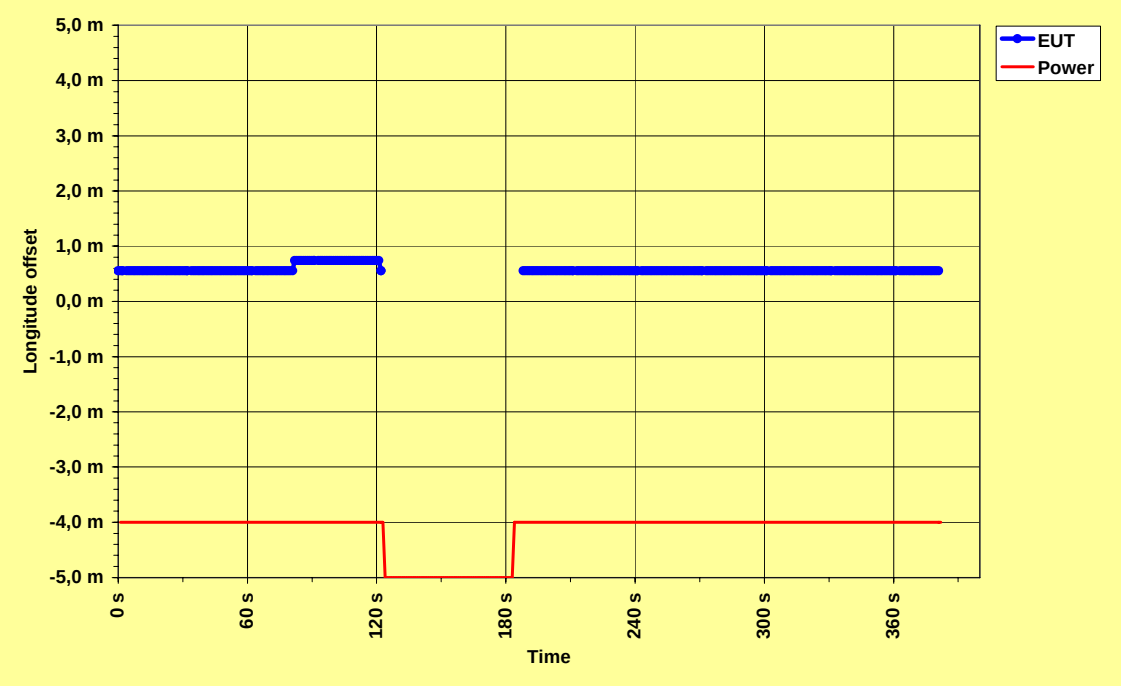
Test result: Passed

For details of validation of recorded data see the following pages.

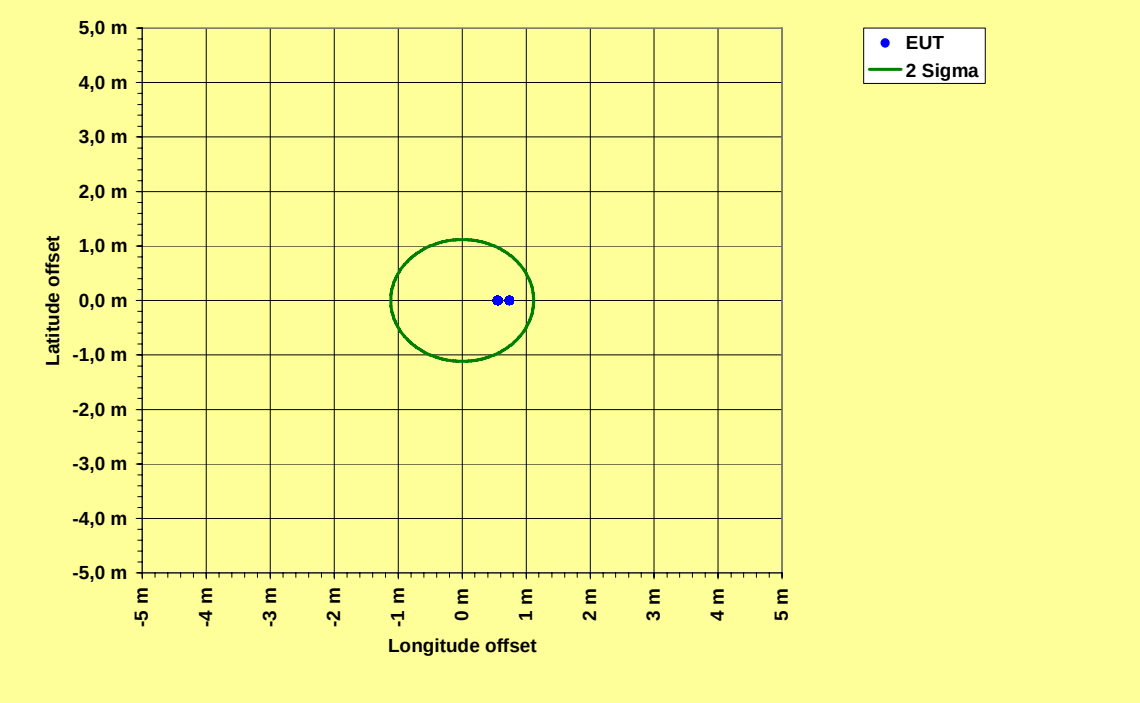
Latitude



Longitude offset



Position offset



B.5 § 5.6.9 Effects of specific interfering signals

Reference position

Made by FREIE UND HANSESTADT HAMBURG
Vermessungsamt –VA311-

Description of point	geocentrically co-ordinates (WGS84)		geodetical geographical co-ordinates (WGS84)		Gauß-Krüger (Bessel)	
North	x(m)	3740601.680	N	53° 32’ 49’’.49049	x(m)	5935502.790
	y(m)	657439.492	E	9° 58’ 6’’.10408	y(m)	3564257.804
	z(m)	5107029.673	Height over Ellipsoid	95.900 m	Altitude above sea level	55.969 m
South	x(m)	3740618.106	N	53° 32’ 48’’.81889	x(m)	5935482.027
	y(m)	657442.338	E	9° 58’ 6’’.10189	y(m)	3564258.046
	z(m)	5107017.296	Height over Ellipsoid	95.849 m	Altitude above sea level	55.917

Accuracy of survey = 0.02 m - last survey dated 2009-05-04

B.5.1 § 5.6.9.1 L-Band interference GPS

In a normal operating mode, using an appropriate signal source, the EUT shall be subjected to radiation of 3 W/m^2 at a frequency of 1636.5 MHz for 10 min. The signal shall be removed and a performance check shall be carried out.

Conditions of tests performed – Real GPS signal

Frequency:	1636.5 MHz
Radiation:	3 W/m^2
Duration of test:	10 min

Test results

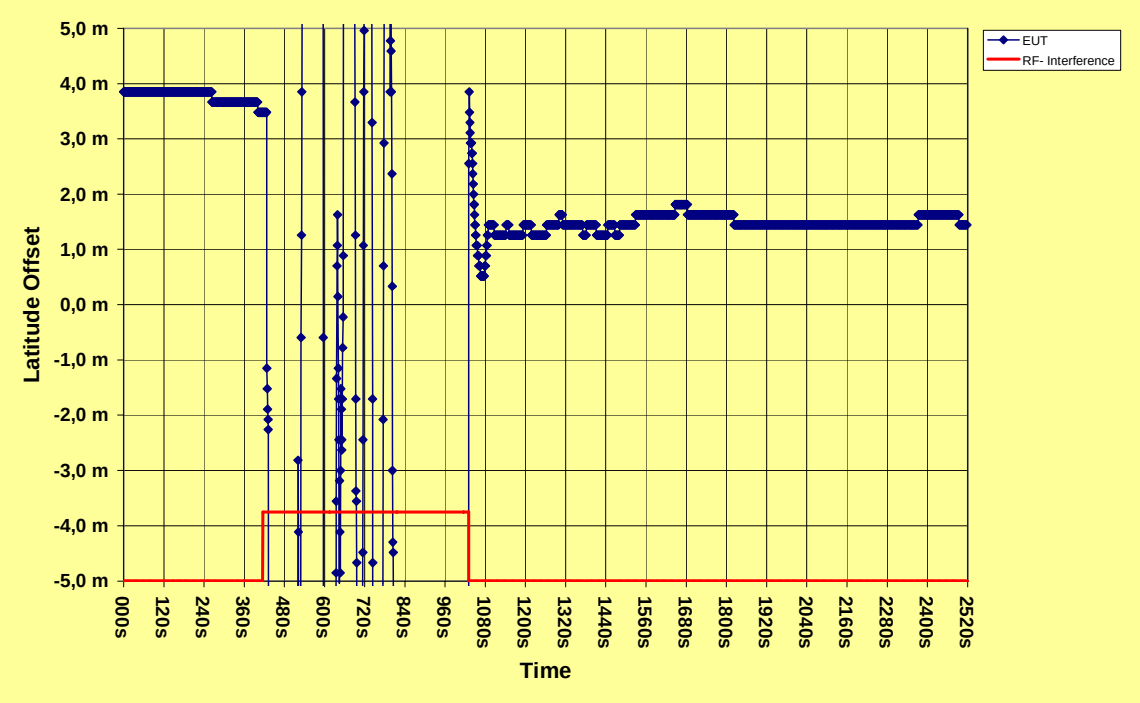
After removing the signal, the performance of the EUT was checked and found operating properly.

Position accuracy: 5.83m (2 sigma)

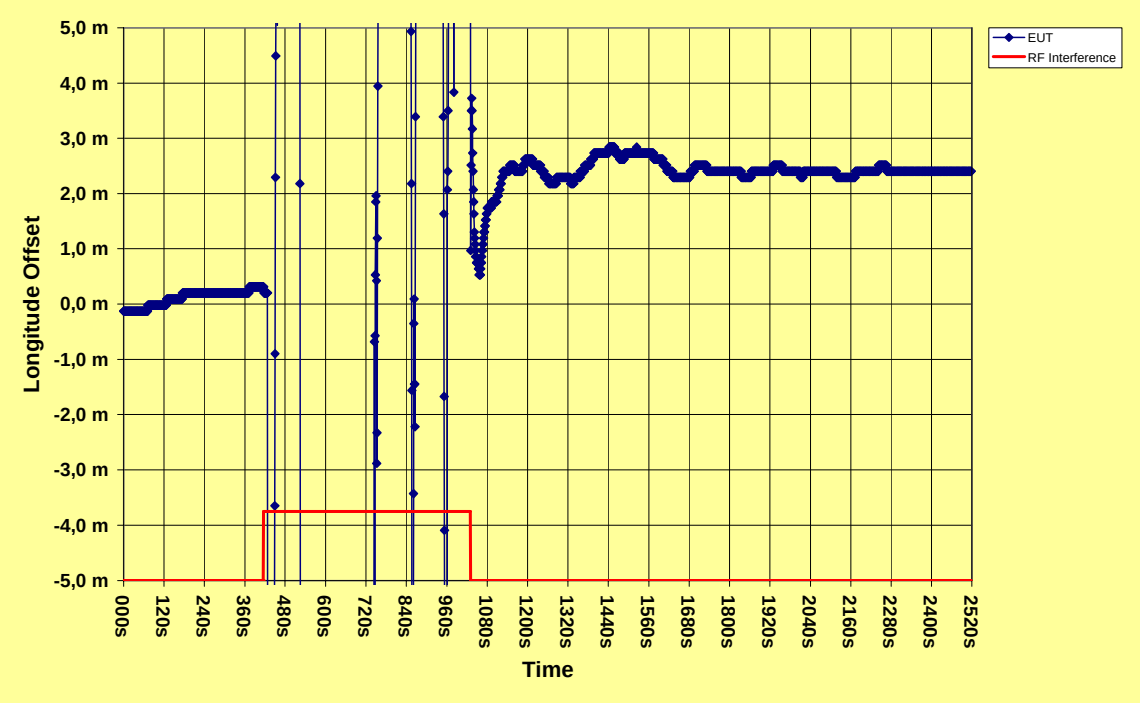
Test result: Passed

For details of validation of recorded data see the following pages.

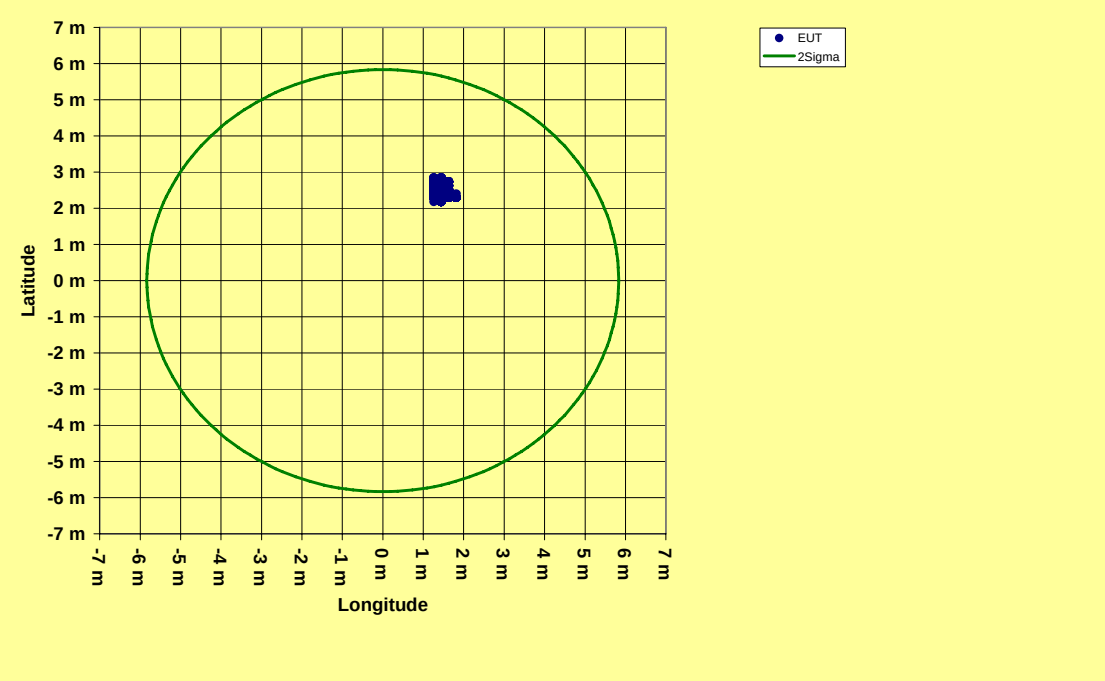
Latitude offset vs. time



Longitude offset vs. time



Position


EUT
2Sigma
Latitude
Longitude
7 m
6 m
5 m
4 m
3 m
2 m
1 m
0 m
-1 m
-2 m
-3 m
-4 m
-5 m
-6 m
-7 m

B.5.2 §5.6.9.2 S- Band interference

In a normal operating mode, using an appropriate signal source, the EUT shall be subjected to radiation consisting of a burst of 10 pulses, each 1.0 to 1.5 µs long on a duty cycle of 1600:1 at a frequency in the range of 2.9 to 3.1 GHz at a power density of approximately 7.5 kW/ m^2. This condition shall be maintained for 10 min with the bursts of pulses repeated every 3 s.
The signal shall be removed and a performance check shall be carried out.

Conditions of tests performed- Real GPS signal

Frequency range:	2.9 to 3.1 GHz
Radiation:	7.5 kW/m^2
Duration of test:	10 min

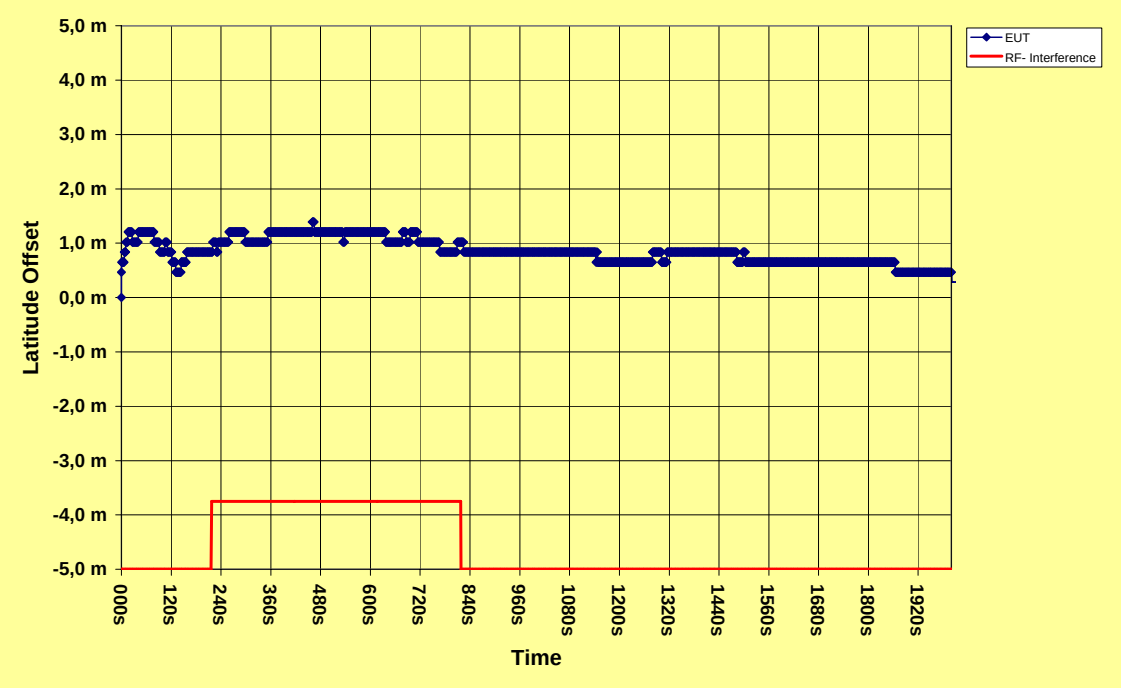
Test results

After removing the signal, the performance of the EUT was checked and found operating properly.
Position accuracy: 1.54m (2 sigma)

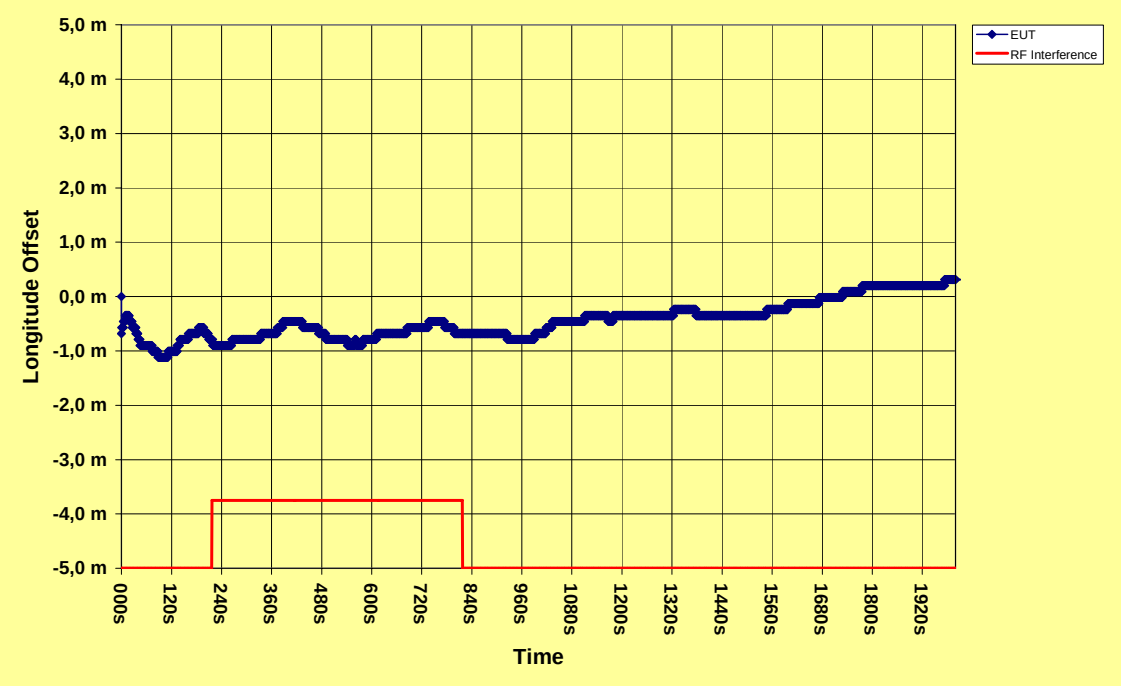
Test result: Passed

For details of validation of recorded data see the following pages.

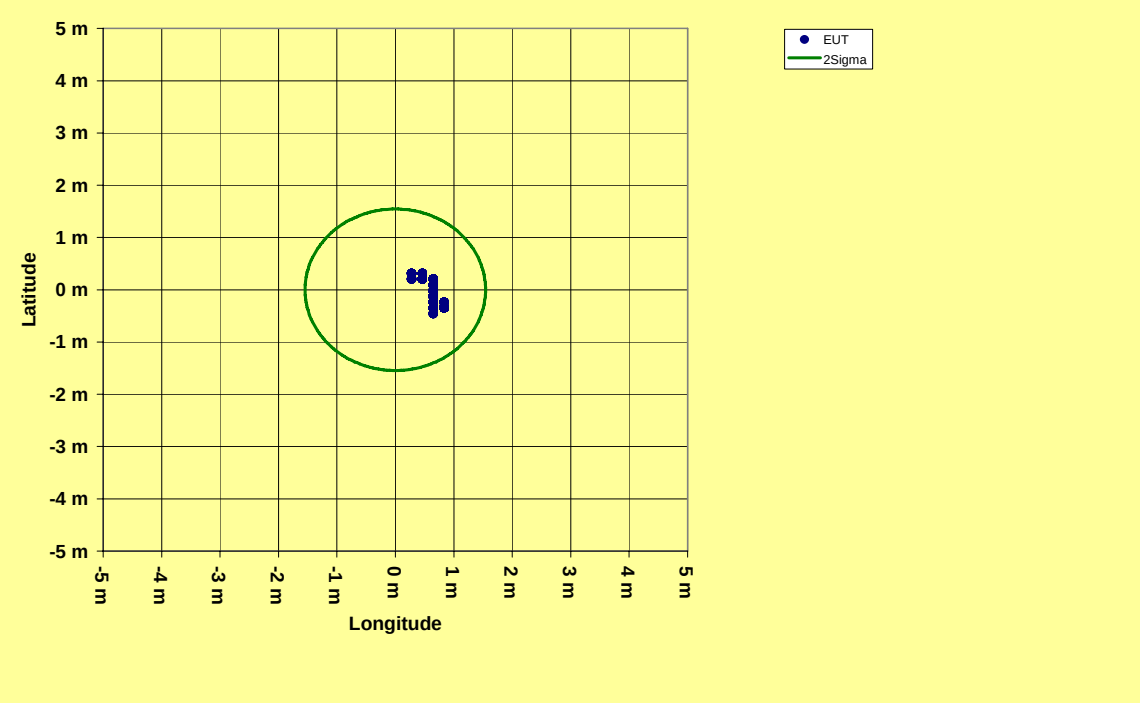
Latitude offset vs. time



Longitude offset vs. time



Position


EUT
2Sigma
5 m
4 m
3 m
2 m
1 m
0 m
-1 m
-2 m
-3 m
-4 m
-5 m
Latitude
-5 m
-4 m
-3 m
-2 m
-1 m
0 m
1 m
2 m
3 m
4 m
5 m
Longitude

B.6 § 5.6.10 Position update

B.6.1 § 5.6.10.1 Slow speed update rate

The EUT shall be placed upon a platform, moving in approximately a straight line, at a speed of 5 knots ±1 knots. The position output of the EUT shall be checked at intervals of 10 s, over a period of 10 min. The output position shall be observed to be updated on each occasion.

This test may be carried out by a simulator.

The minimum resolution of position, i.e. latitude and longitude shall be checked by observation during §5.6.10.1.

Record the IEC 61162 output of the EUT during this test and confirm that received positions at the end of each interval are in compliance with the real or simulated reference position.

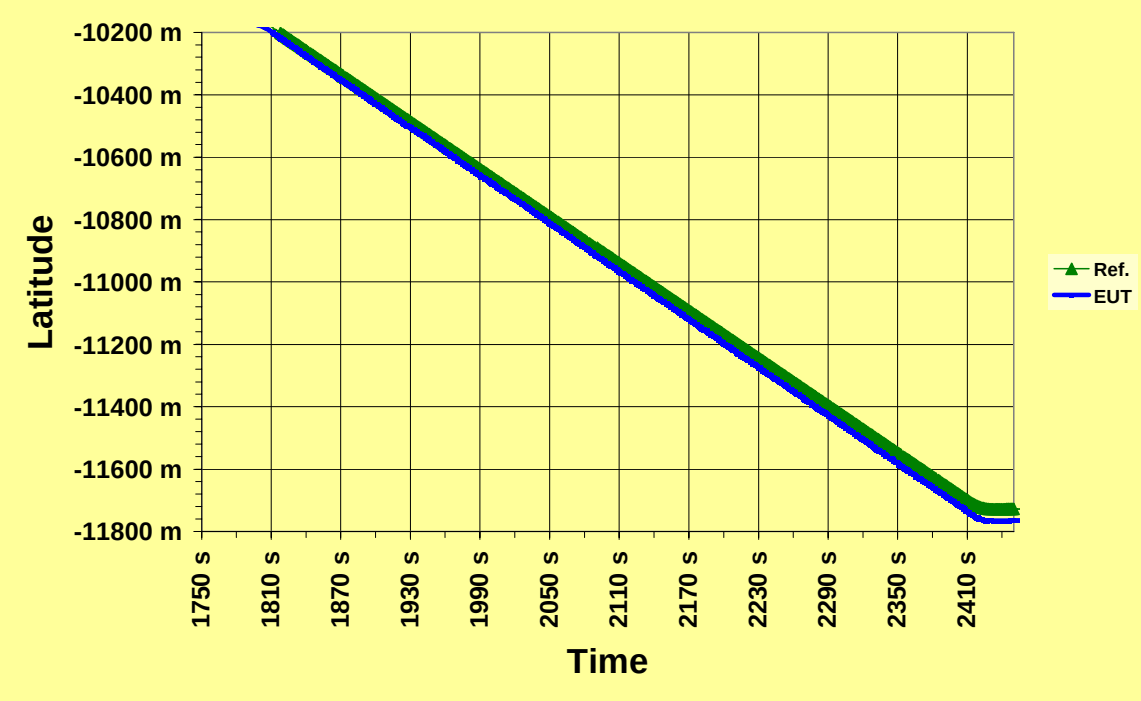
Conditions of tests performed

Tests performed by using a simulator

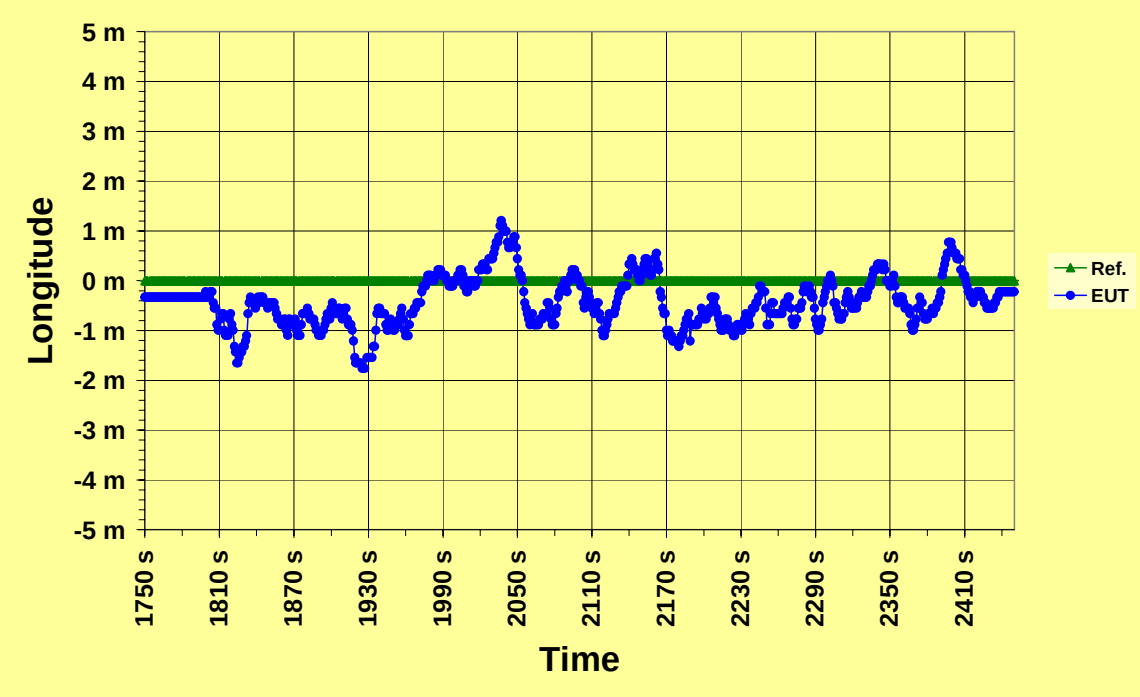
Test result: Passed

For details of validation of recorded data see the following pages.

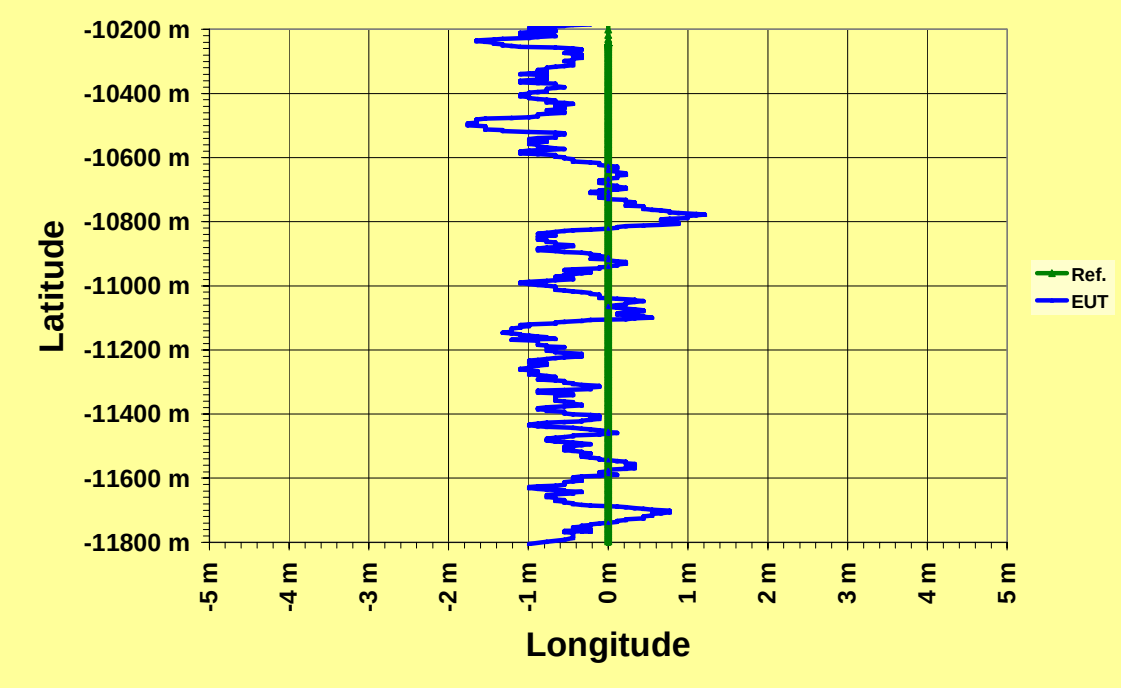
Latitude 5.0knots



Longitude 5.0knots



Position 5.0knots



B.6.2 § 5.6.10.2 High speed update rate

The EUT shall be placed upon a platform, moving in approximately a straight line, at a speed of 50 knots ±5 knots. The position output of the EUT shall be checked at intervals of 10 s, over a period of 10 min. The output position shall be observed to be updated on each occasion.

This test may be carried out by a simulator with a speed of 70 knots at intervals of 0.5 s.

The minimum resolution of position, i.e. latitude and longitude shall be checked by observation during 5.6.10.2.

Record the IEC 61162 output of the EUT during this test and confirm that received positions at the end of each interval are in compliance with the real or simulated reference position.

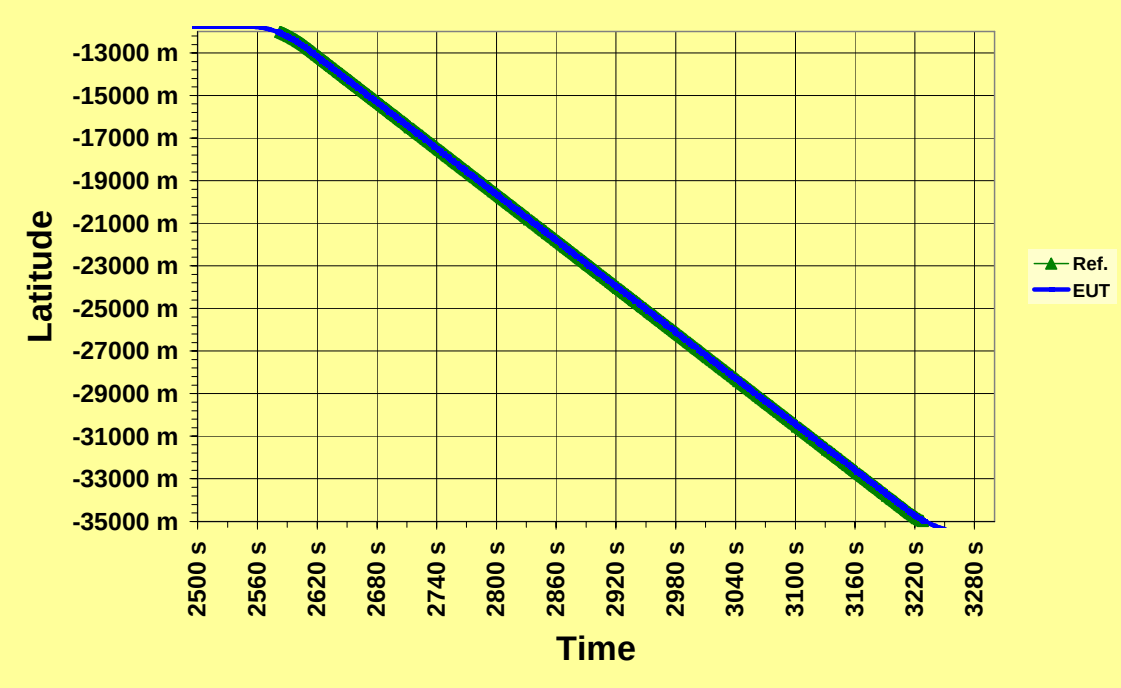
Conditions of tests performed

Tests performed by using a simulator

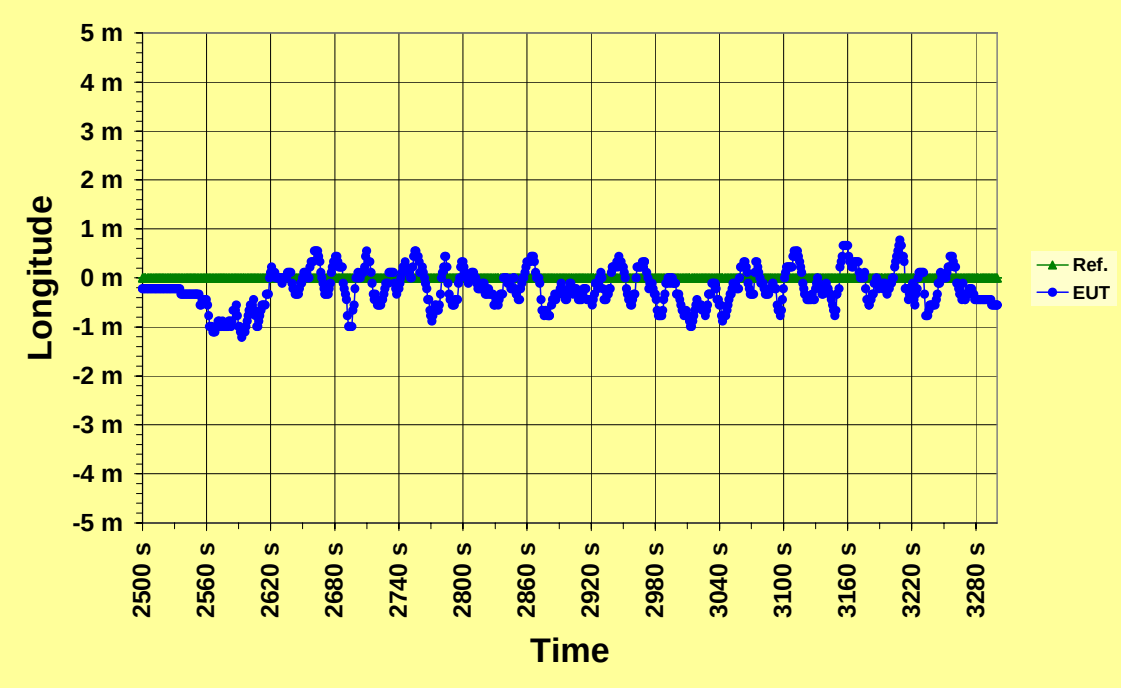
Test result: Passed

For details of validation of recorded data see the following pages.

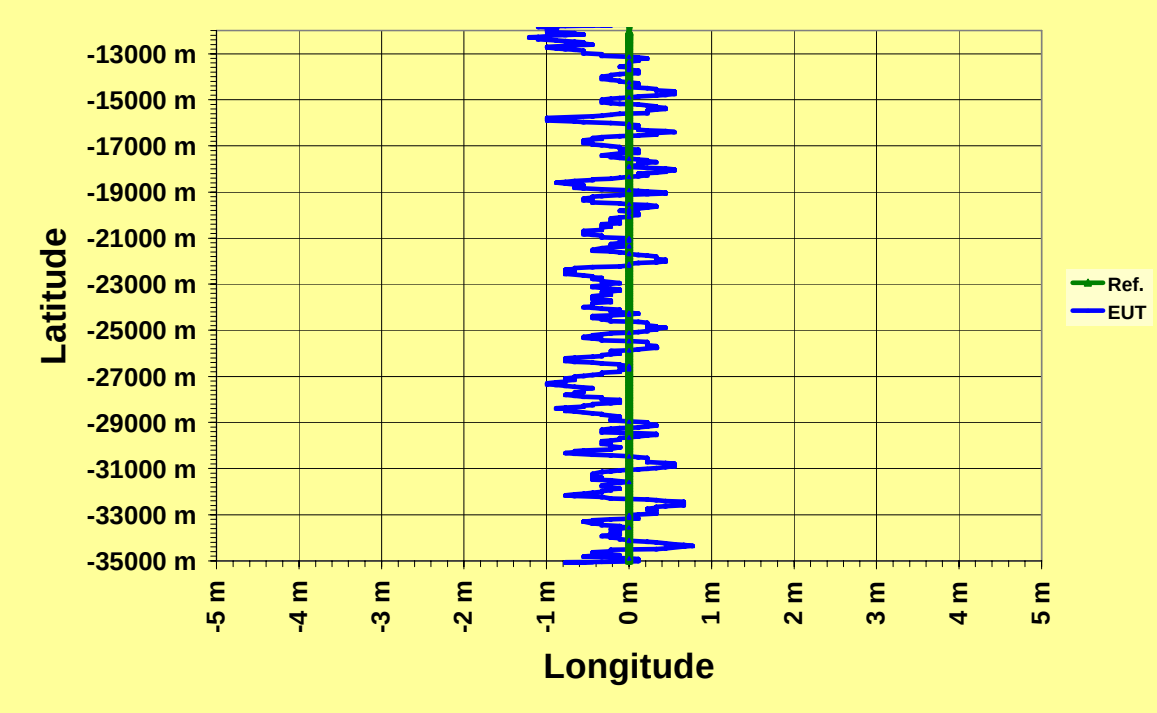
Latitude 70.0knots



Longitude 70.0knots



Position 70.0knots



B.7 § 5.6.12 Failure warnings and status indication

B.7.1 Simulation scenarios for test of RAIM functionality

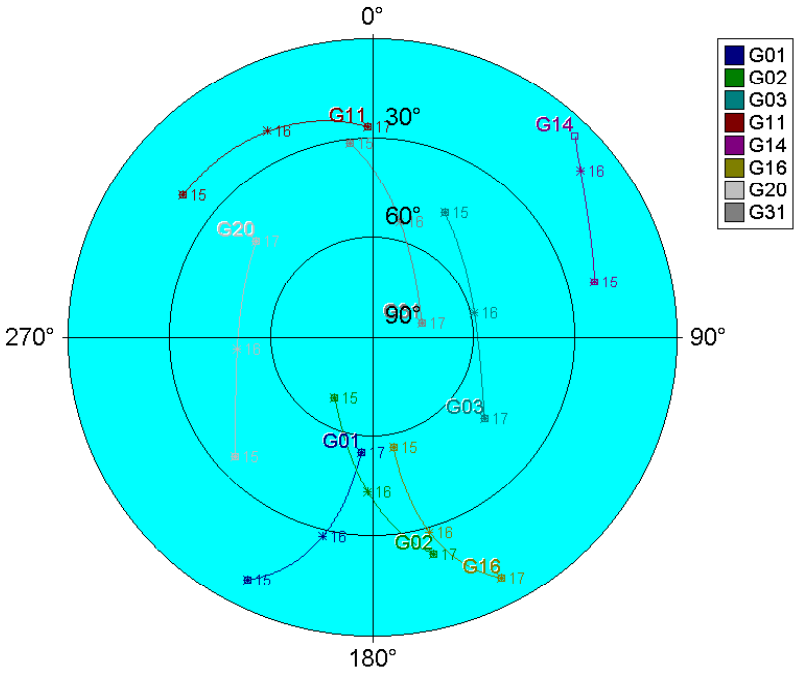
Reference position

Made by GPS-Simulator

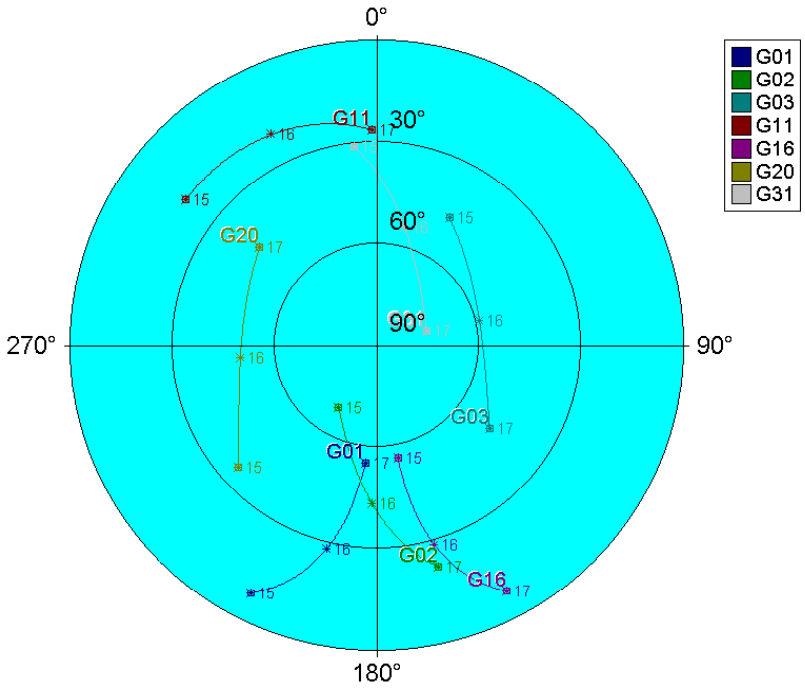
	geocentrically co-ordinates (WGS84)
Latitude	0.00000000000 ° N
Longitude	0.00000000000 ° E

Simulated constellations

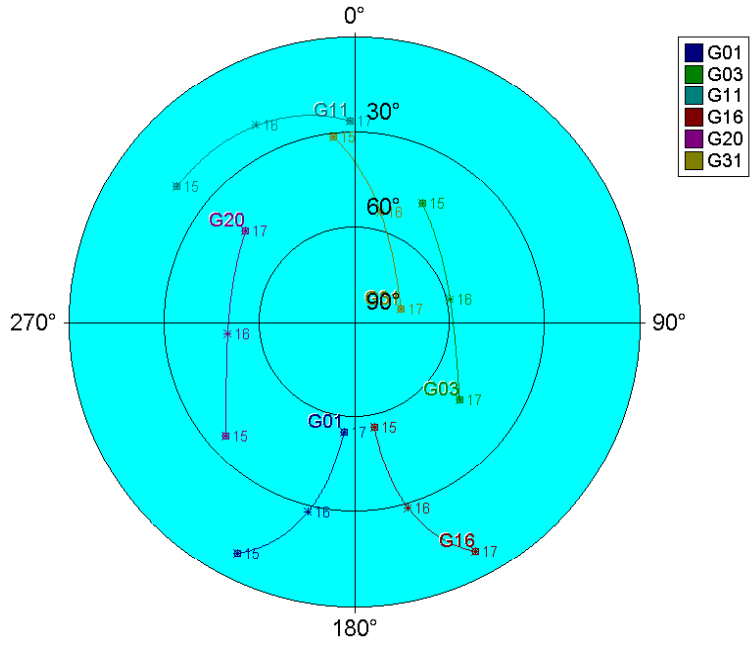
Simulated constellation with 8 satellites



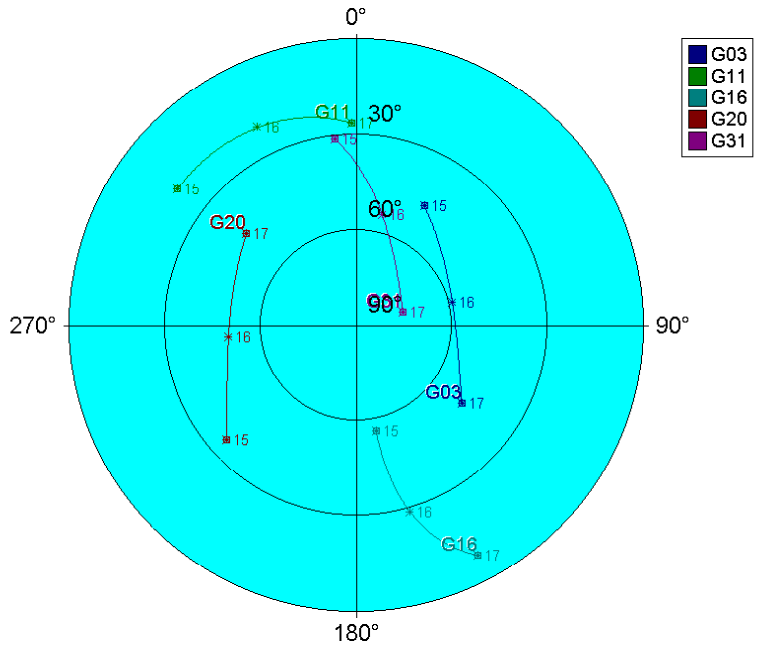
Simulated constellation with 7 satellites



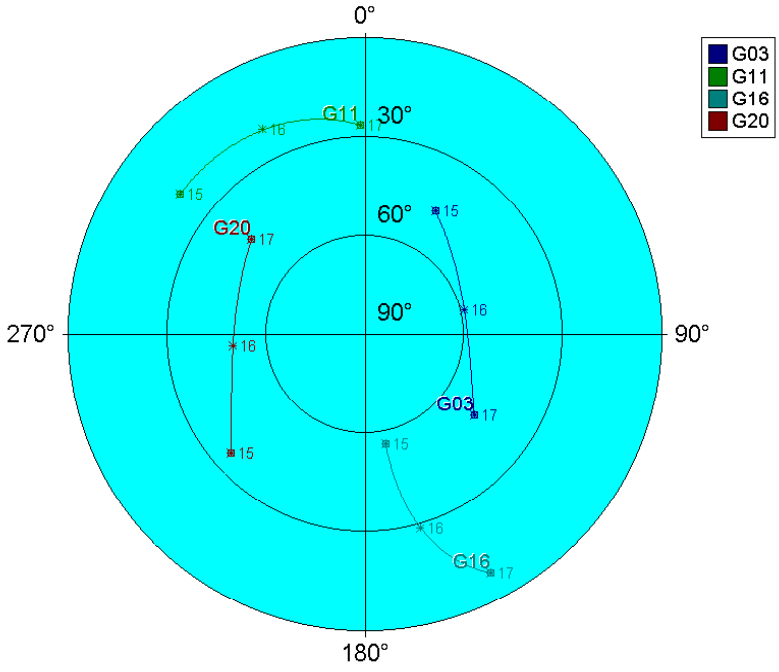
Simulated constellation with 6 satellites



Simulated constellation with 5 satellites



Simulated constellation with 4 satellites



RAIM test scenario

Scenario: W224_1500_8_TO_4_SAT_RAMP_SHORT.SCEN;3

15:00:00 Pseudorange - Ramp: 500 m
4 min. Ramp up, 1 min. Hold, 4 min. Ramp down
Sat.-Ids: 1, 2, 3, 11, 14, 16, 20, 31

8 Satellites					7 Satellites					6 Satellites					5 Satellites					4 Satellites					
00:00:00	00:15:00	00:19:00	00:20:00	00:24:00	**00:27:00**	00:28:00	00:32:00	00:33:00	00:37:00	**00:40:00**	00:41:00	00:45:00	00:46:00	00:50:00	**00:53:00**	00:54:00	00:58:00	00:59:00	01:03:00	**01:06:00**	01:07:00	01:11:00	01:12:00	01:16:00	**01:19:00**
Sat. Off	Ramp up	Ramp hold	Ramp down	Ramp end	**Sat. Off**	Ramp up	Ramp hold	Ramp down	Ramp end	**Sat. Off**	Ramp up	Ramp hold	Ramp down	Ramp end	**Sat. Off**	Ramp up	Ramp hold	Ramp down	Ramp end	**Sat. Off**	Ramp up	Ramp hold	Ramp down	Ramp end	
13	**14**				**14**	**2**				**2**	**1**				**1**	**31**				**31**	**20**				
22																									
25																									
27																									
28																									

B.7.2 § 5.6.12.2 Test of integrity monitoring using RAIM

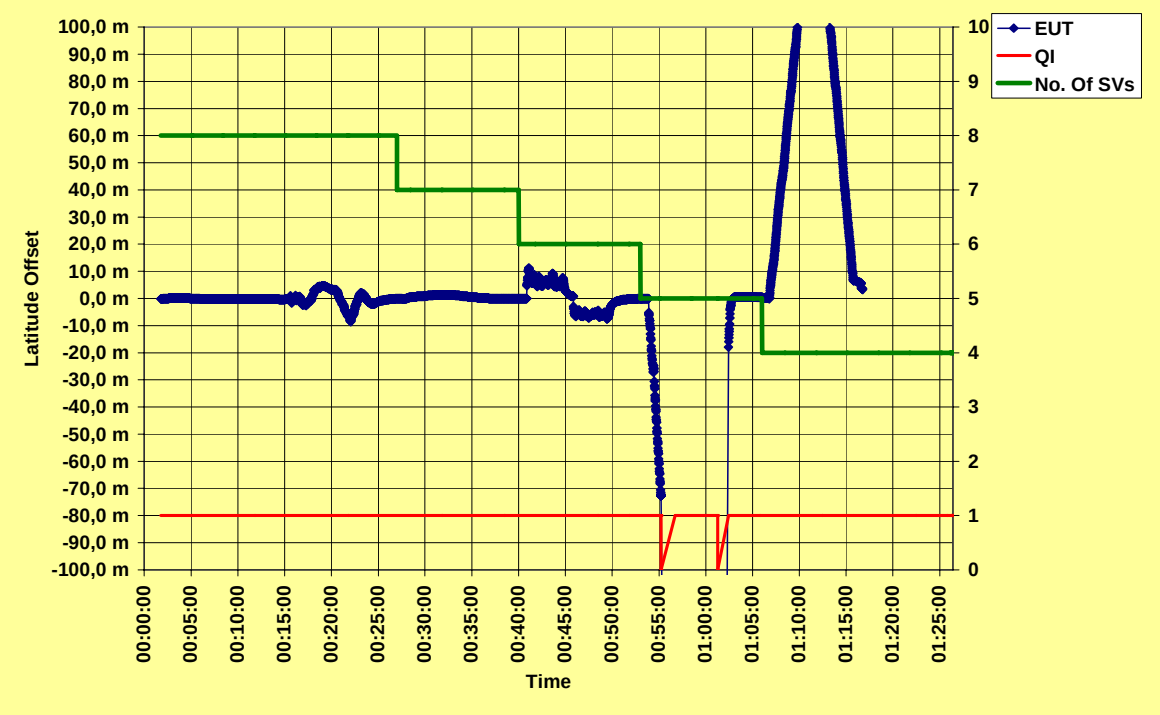
This test applies to 4.3.11.2.

For AIS systems this test is carried out to ensure that a RAIM algorithm is implemented and the faulty satellite exclusion is used to minimize the risk of false position calculation.
For less than 5 SVs (Space Vehicles) RAIM is unreliable or unavailable.

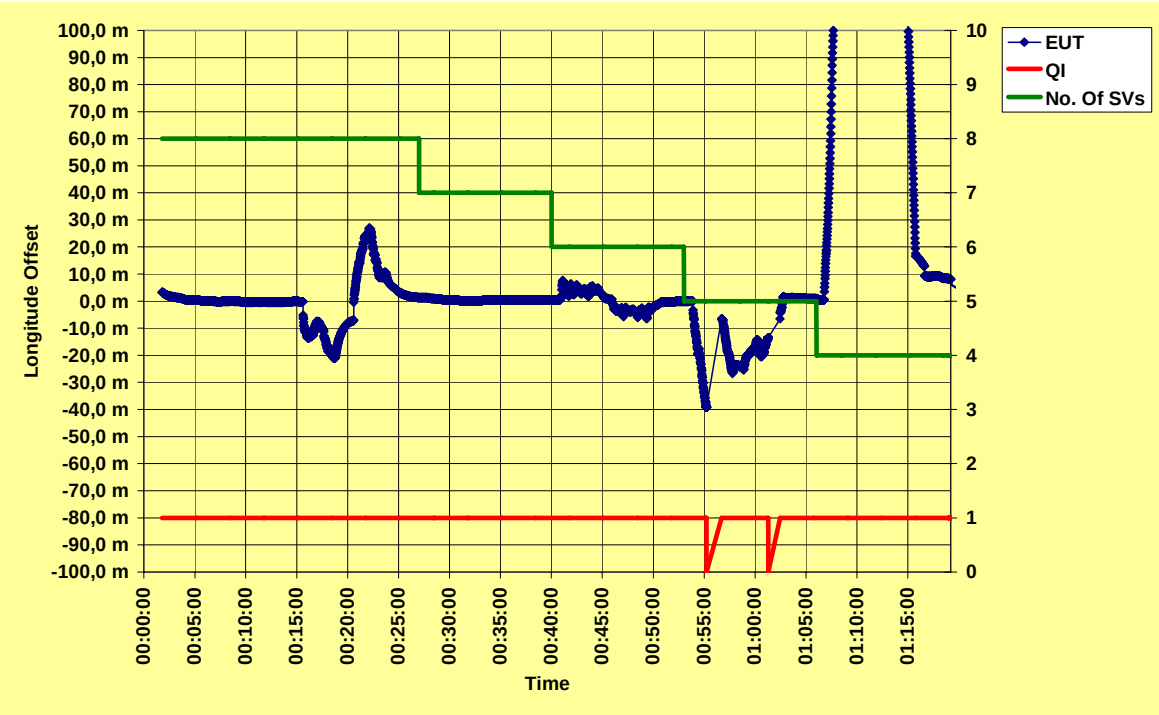
Test result: Passed

For details of validation of recorded data see the following pages.

Latitude offset, quality indicator and available SVs vs. time



Longitude offset, quality indicator and available SVs vs. time



B.8 § 5.6.13 Accuracy of COG and SOG

The EUT shall be set up on an appropriate mobile unit or simulator and all outputs indicating course over ground shall be monitored.

At a constant forward direction, the forward speed shall be within 0 knots to 1 knot.
Ten seconds after being in the range, measurements shall be made for a duration of 2 min.
This cycle shall be repeated for all speed ranges of the table below.

Table – Accuracy of COG

Speed range (knots)	Tested value	Accuracy of COG output to user
0 to ≤1 knot	(~0.5 kn)	Unreliable or nor available
>1 to ≤17 knots	(~14.52 kn)	± 3 °
> 17 knots	(~24.3 kn)	± 1 °

Required results

The test results shall be observed the display and the approved interface.

For SOG tests, no reading of the speed indicator shall differ from the constant speed being applied at the time by more than 2 % of that speed or 0.2 knots, whichever is the greater.

For COG tests, the difference between the reference direction and measured course over ground of in each test cycle shall not exceed the limits in the table.

Conditions of tests performed

Tests performed by using a simulator

Test result: Passed

For details of validation of recorded data see the following pages.

Validity of COG and SOG information

Method of testing

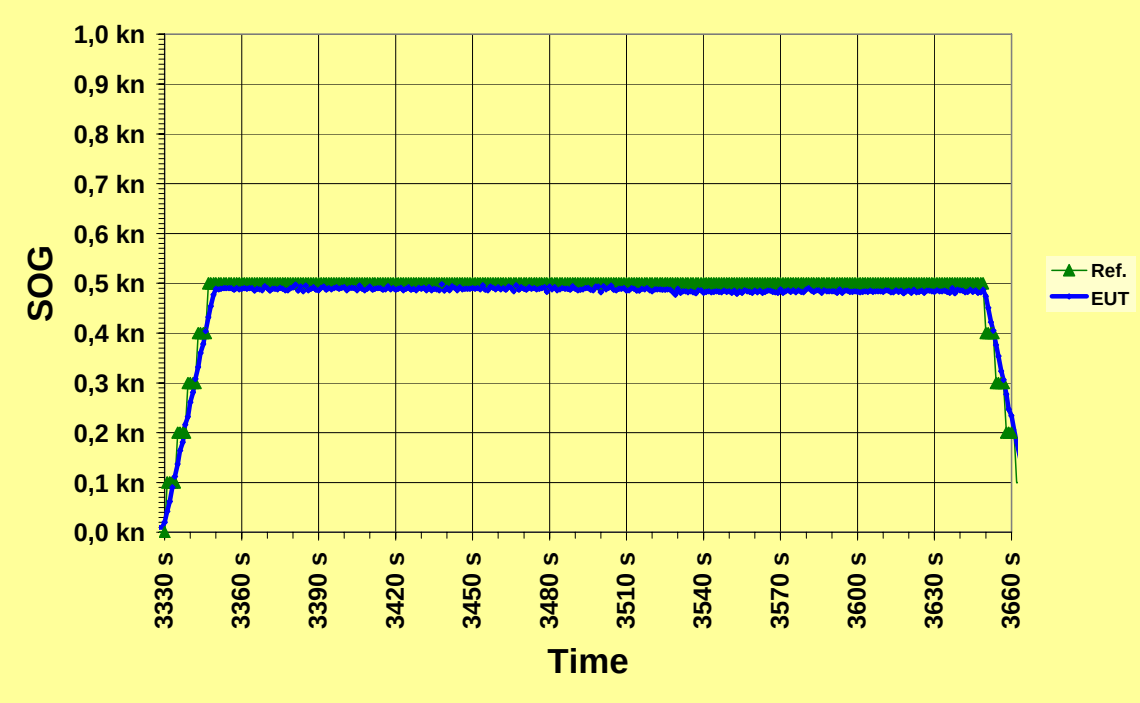
Check digital interface with IEC 61162. With the EUT normally operating, preclude invalid position by reducing the number of received satellites. Investigate the content of the resultant AIS VDO Messages.

Required result

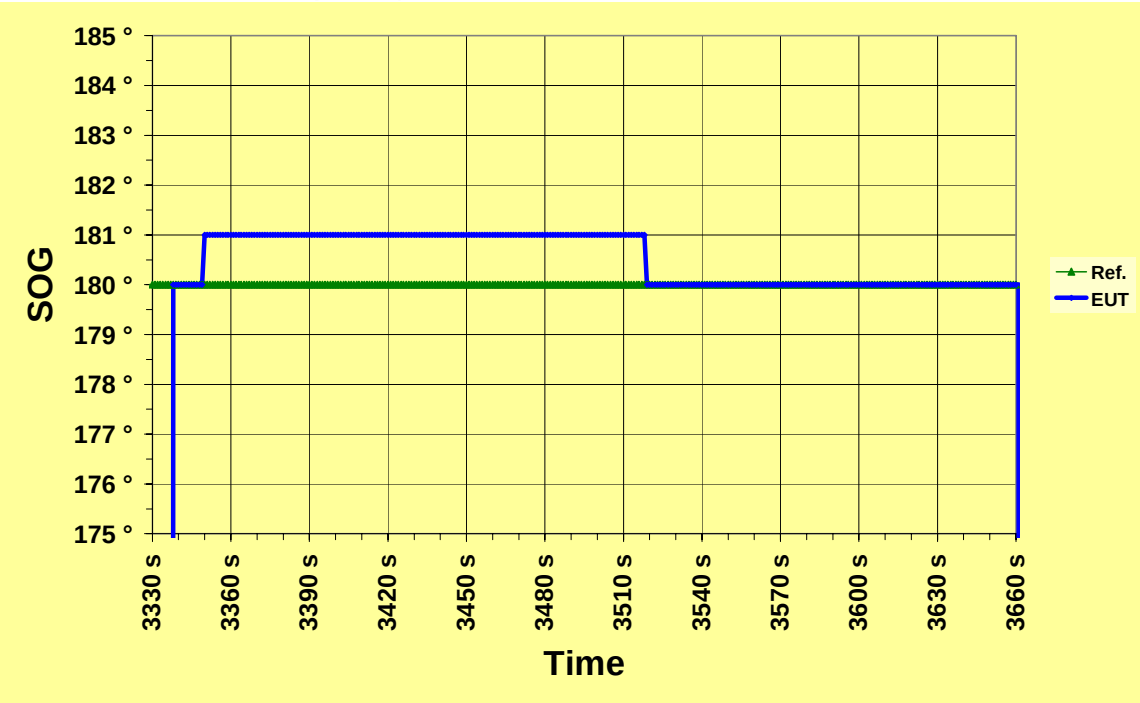
Observe that the COG and SOG information contained in AIS VDO message of IEC 61162 is replaced by "default values".

Test result: Passed

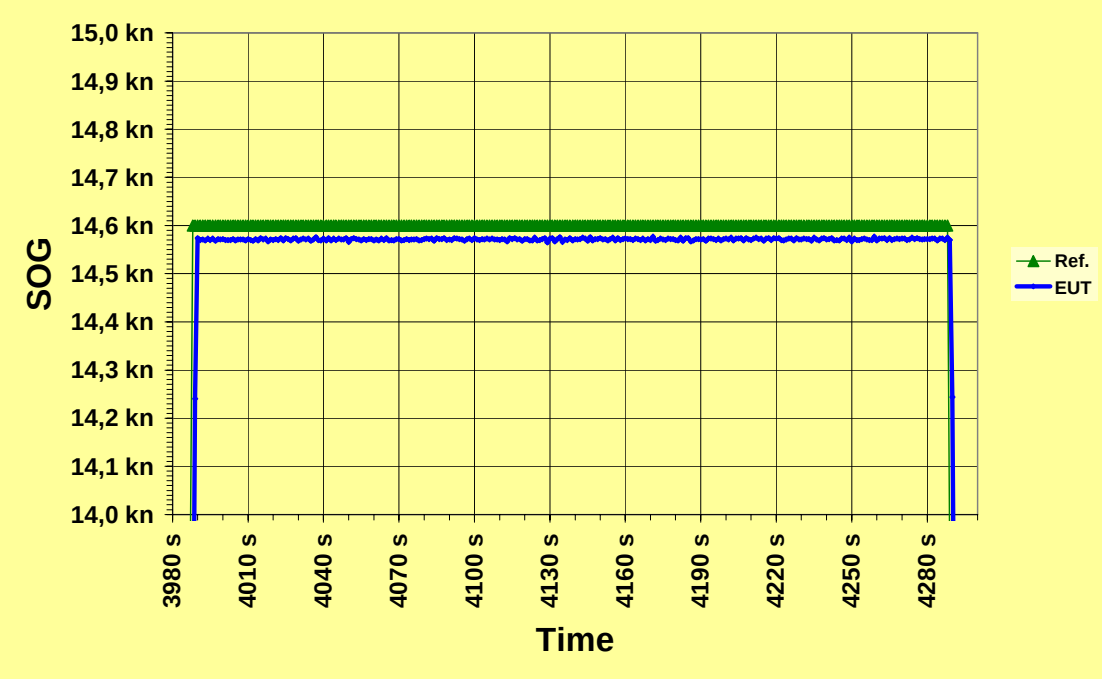
Speed over ground (SOG) vs. time, @ 0.48 Knots



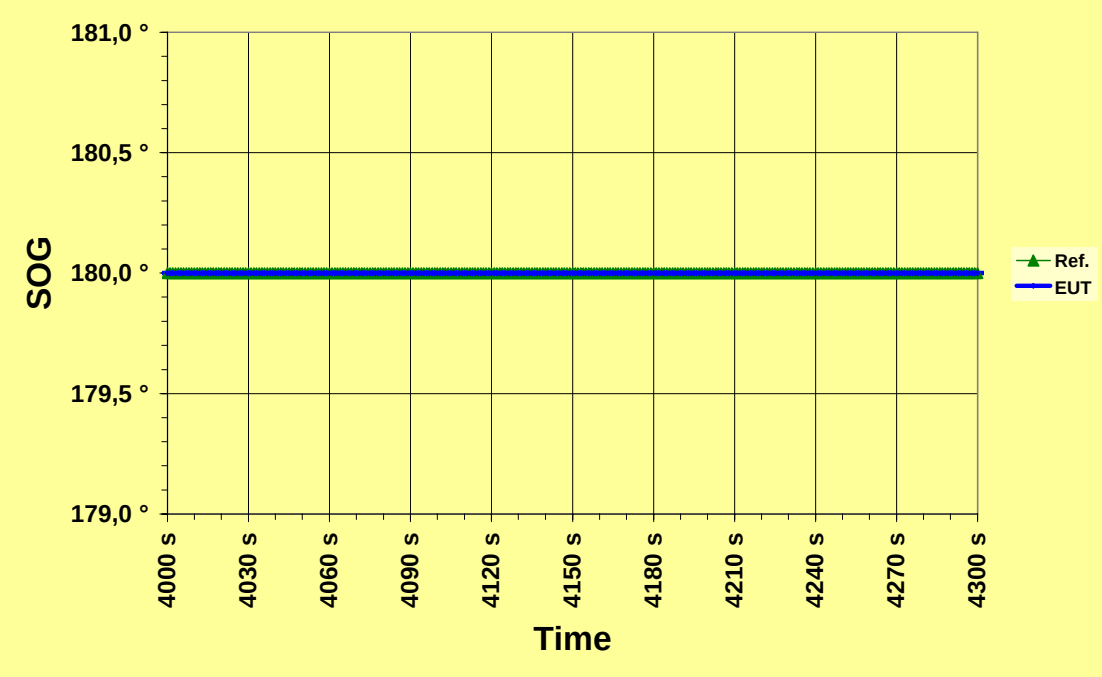
Course over ground (COG) vs. time, @ 0.48Knots



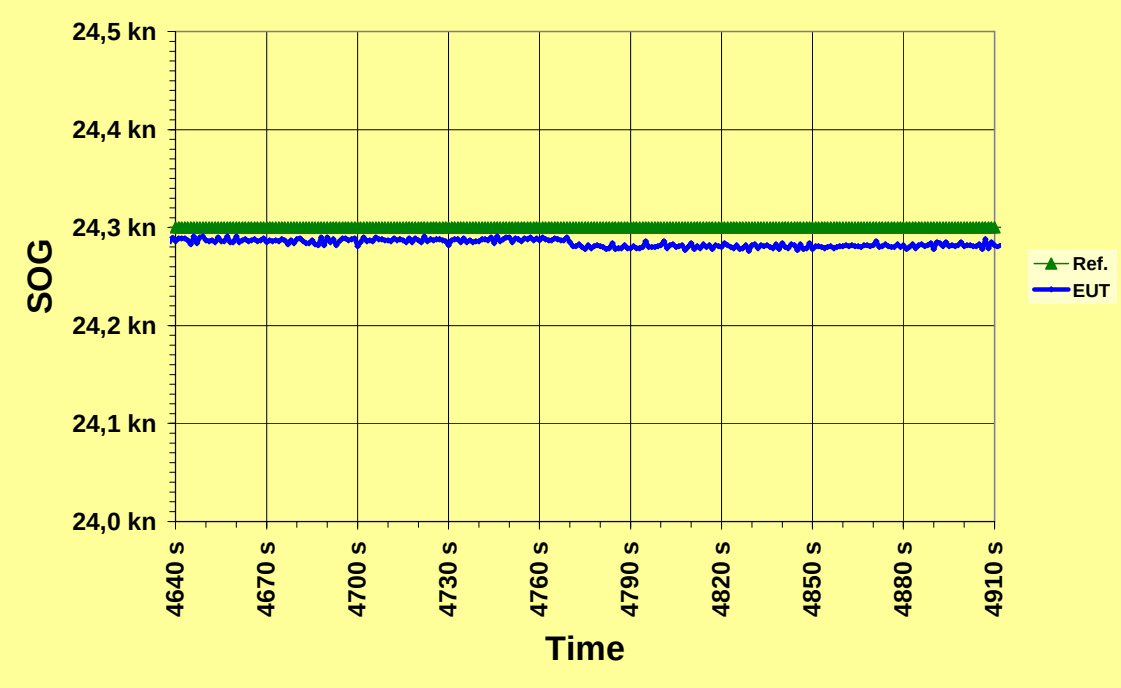
Speed over ground (SOG) vs. time, @ 14.6Knots



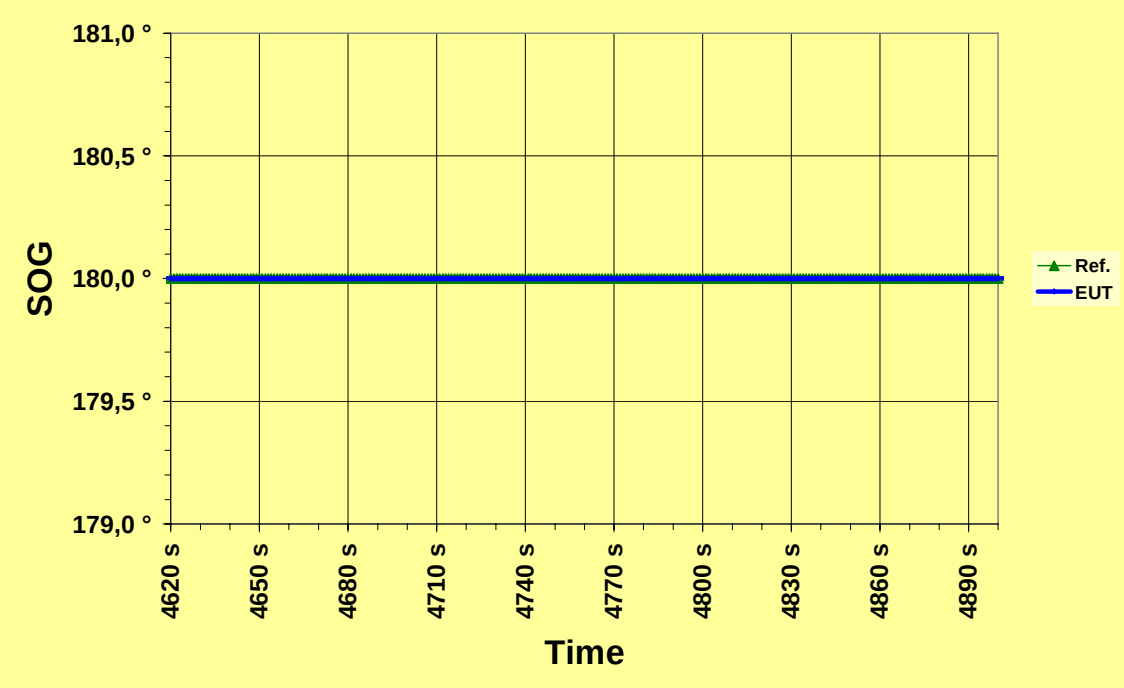
Course over ground (COG) vs. time, @14.6Knots



Speed over ground (SOG) vs. time, @ 24.3Knots



Course over ground (COG) vs. time, @ 24.3Knots



B.9 § 5.7.2 Testing interference

B.9.1 § 5.7.2.4.1 Interference conditions

Interference conditions, including broadband noise centred at 1575.42 MHz, continuous wave interference (CWI), and pulsed interference shall be simulated. For the pulsed interference tests, a pulse-modulated carrier (CW) with peak carrier level of −20 dBm and duty factor of 10 % shall be used. The interference values are shown in the three tables below.

Broadband interference values		
Noise bandwidth (MHz)	Requested total RMS power (dBm)	Applied interference
1	-110.5	-110.5 dBm at 1MHz

Pulsed interference values		
Frequency (MHz)	Pulse width (ms)	Applied interference
1575.42	1	1 ms at 1575.42 MHz

Continuous wave interference (CWI) values		
Frequency (MHz)	Requested power (dBm)	Applied interference
1575.42	-120.5	-120 dBm at 1575.42 MHz
1626.0	+8.0	-80 dBm at 1596.0 MHz

§ 5.7.2.4.2 Test procedures

a) The equipment under test is subjected to one of the interference sources.
b) The simulator scenario shall be engaged and the satellite signals turned on.
c) The equipment under test shall be powered and initialised.
d) While the EUT is providing position solutions, the interference shall be applied to the equipment under test, and the level of the interference shall be adjusted to the required value.
e) When steady-state accuracy is reached, record a minimum of 100 position and HDOP value as reported by the EUT at a rate of one sample every 2 min.
f)Repeat this cycle for any remaining interference source.

B.9.1.1 § 5.7.2.4.3 Required results

Pass/fail determination

If the EUT reports a position with a normalised error greater than 10 m or fails to report a position in more than 5 % of the samples, a test failure is declared.

Remark: Due to normalizing of the position error in reference to an HDOP of 4, values for normalized error can show wide ranges in case of measured HDOP values around 1.0 or even below. Test passed, if the calculated position is well within GPS position accuracy level defined by IEC61108-1 Ed. 2 (for standard GPS= 13.0m).

Conditions of tests performed

Tests performed using a simulator, date: 2010/10/21.

Broadband noise (–110.5dBm @ 1MHz bandwidth)

13:12 - 2010/10/21	Test start
13:15:00	Interference start
13:25:00	Interference stop
14:23 - 2010/10/21	Test end

Pulsed interference (–20 dBm at 1575.42 MHz with 1 ms pulse width)

13:12 - 2010/10/21	Test start
13:30:00	Interference start
13:40:00	Interference stop
14:23 - 2010/10/21	Test end

Continuous wave interference (-120.5 dBm at 1575.42 MHz)

13:12 - 2010/10/21	Test start
13:45:00	Interference start
13:55:00	Interference stop
14:23 - 2010/10/21	Test end

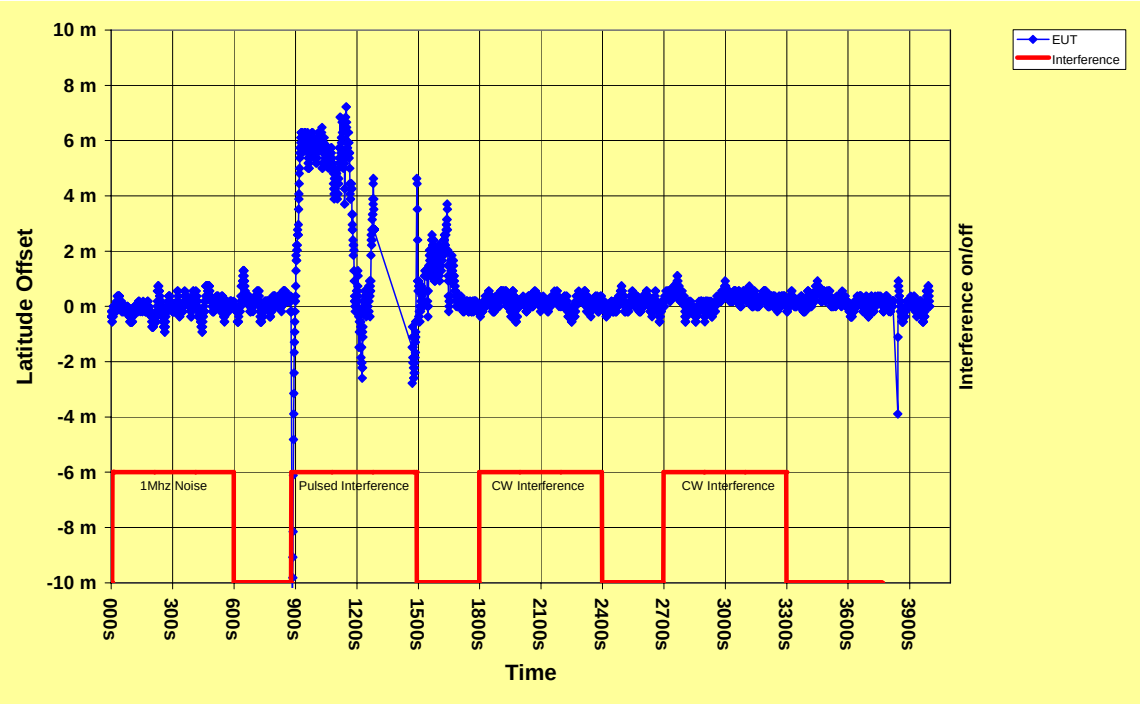
Continuous wave interference (-80 dBm at 1596 MHz)

13:12 - 2010/10/21	Test start
14:00:00	Interference start
14:10:00	Interference stop
14:23 - 2010/10/21	Test end

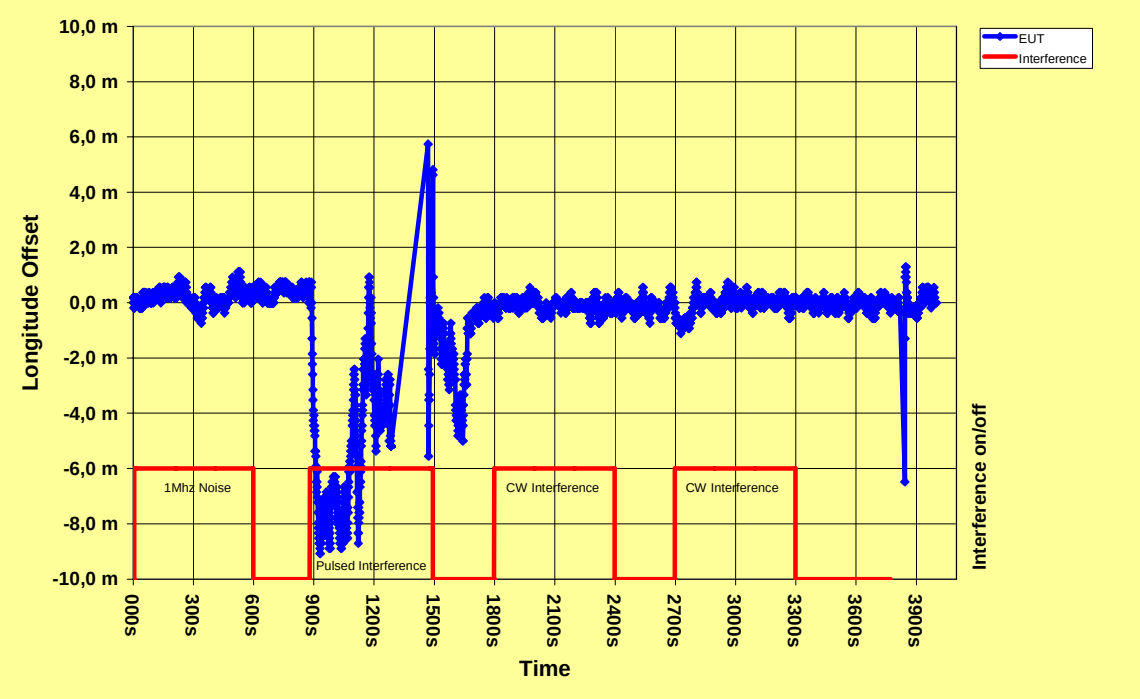
Test result: Test passed

For details of validation of recorded data see the following pages.

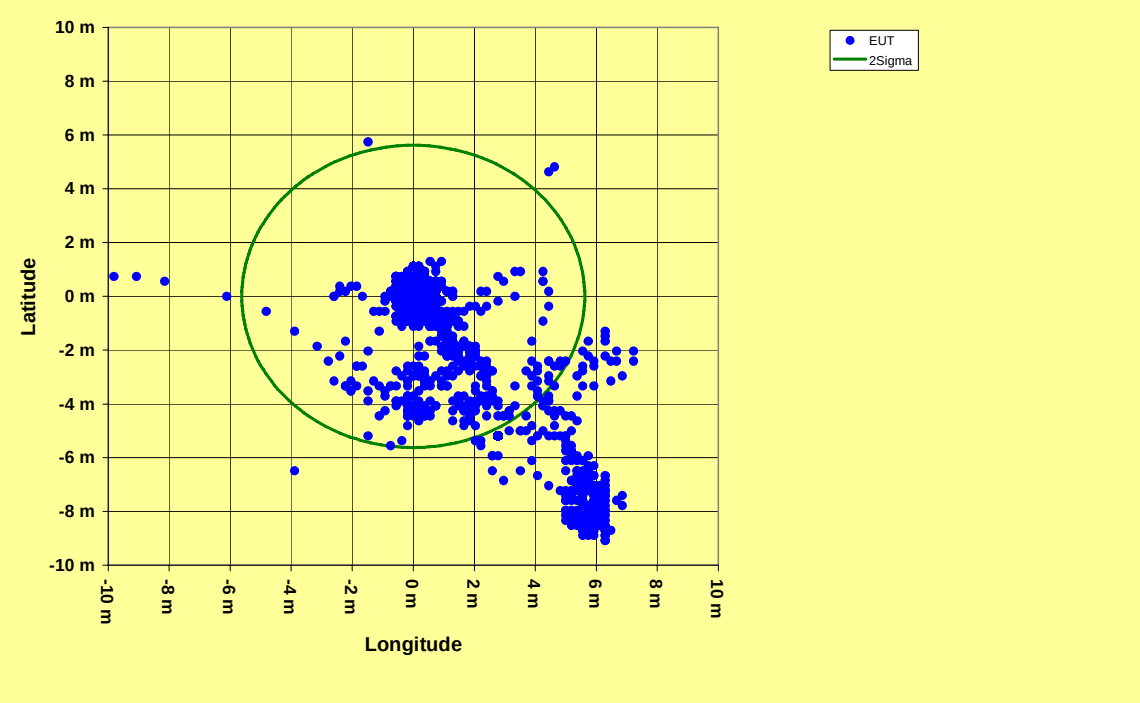
Latitude offset and interference vs. time



Longitude offset and interference vs. time



Position offset during all interference scenarios



Note: 2 Sigma value during all interference conditions: 5.62m

B.9.2 § 5.7.2.5 Reaquisition test

Method of test

The reacquisition test is designed to simulate a temporary loss of signal, such as Passing under a bridge. To determine the re-acquisition pass/fail criteria, consider a single trial where the EUT provides a valid position fix that is within required accuracy at 30 s from restoration of the satellite signals, and maintains a tracking status for at least the next 60 s. This unit is considered to have passed one trial.

§ 5.7.2.5.1 Re-acquisition test procedures
§ 5.7.2.5.2 Interference conditions

The interference condition to be tested is shown below. This is a broadband noise Value centred at 1575.42 MHz.

Noise bandwidth (MHz)	Total RMS power (dBm)
1	−110.5

§ 5.7.2.6 Re-acquisition scenarios
§ 5.7.2.6.1 Test procedures

a) The equipment under test is subjected to the broadband interference source.
b) The simulator scenario shall be engaged and the satellite signals turned on.
c) The equipment under test shall be powered and initialised.
d) The EUT shall be allowed to reach steady-state accuracy before the satellites are to be switched off.
e) The simulator RF output shall be removed for 30 s.
f) The simulator RF output shall be restored to the EUT.
g) After 30 s record a position and HDOP value as reported by the EUT. If after 30 s, no position report has been sent from the receiver, record a trial failure and go to step i).
h) Ensure that the receiver continues position reporting for the next 60 s.
i) Go to Step d) and repeat as required. (note that if the simulator scenario is reset, some receivers may require purging of all previous data to enable proper operation. This is due to the persistence of time data in the receiver and the inability of the receiver's software to deal with a backward transition in time).

B.9.2.1 § 5.7.2.6.2 Required results

Pass/fail determination

A failure by the EUT to provide a position output after 30 s, reporting a position with normalised error greater than 10 m, or failing to continue position reporting for 60 s after sampling indicates a failure mode, and results in declaring a trial failure. To determine the reacquisition time pass/fail criteria, the test disposition table shall be used.

Conditions of tests performed

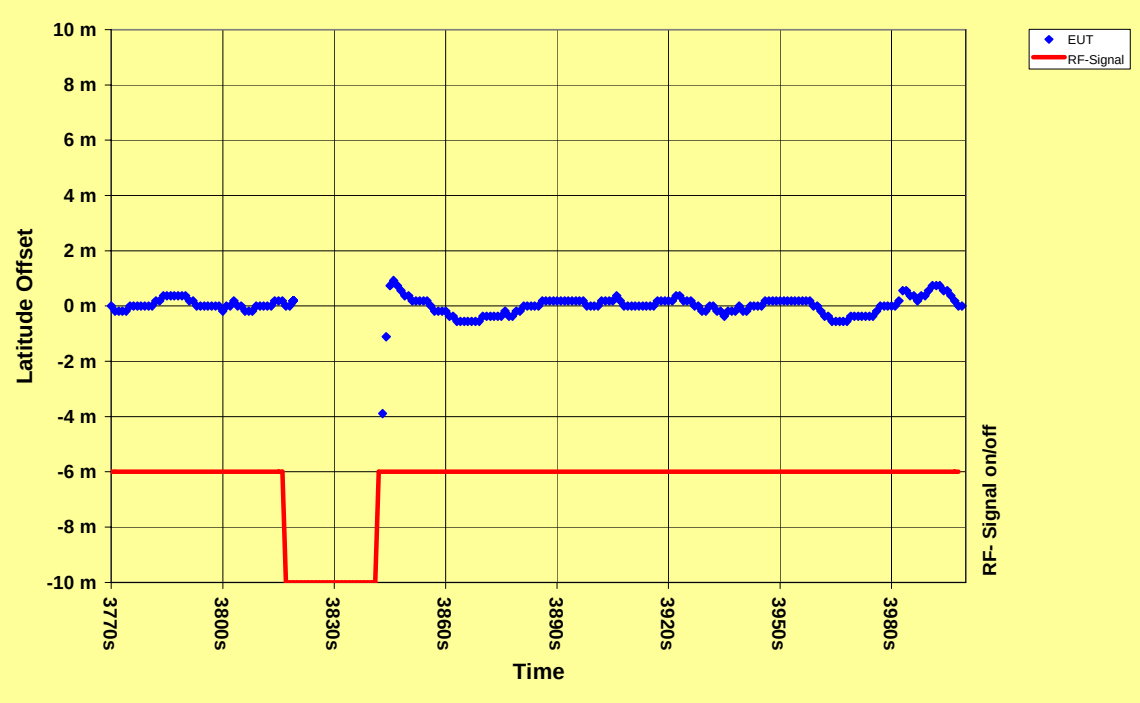
Tests performed using a simulator.

13:12 - 2010/10/21	Test start
14:15:40	Satellite signal shielded
14:16:10	shield removed
14:23 - 2010/10/21	Test end

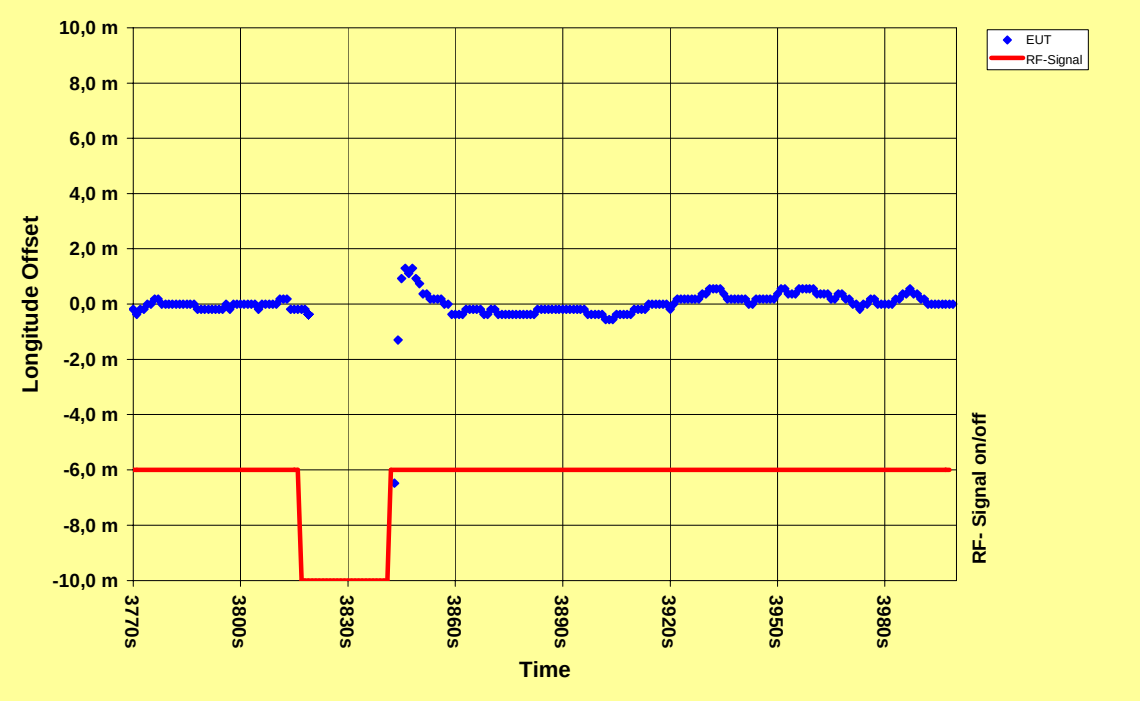
Test result: Passed

For details of validation of recorded data see the following pages.

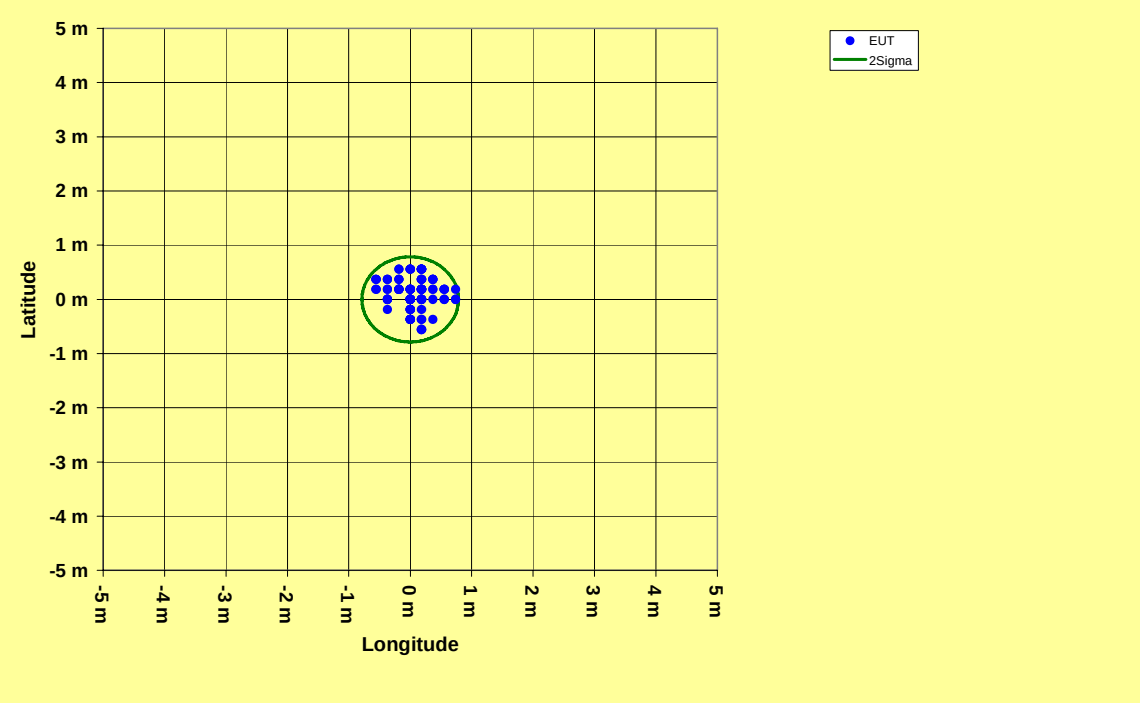
Latitude offset vs. time



Longitude offset vs. time



Position offset after time limit of 30seconds after restored RF signal



Note: 2 Sigma value 90sec after RF- signal had been restored: 0.79m

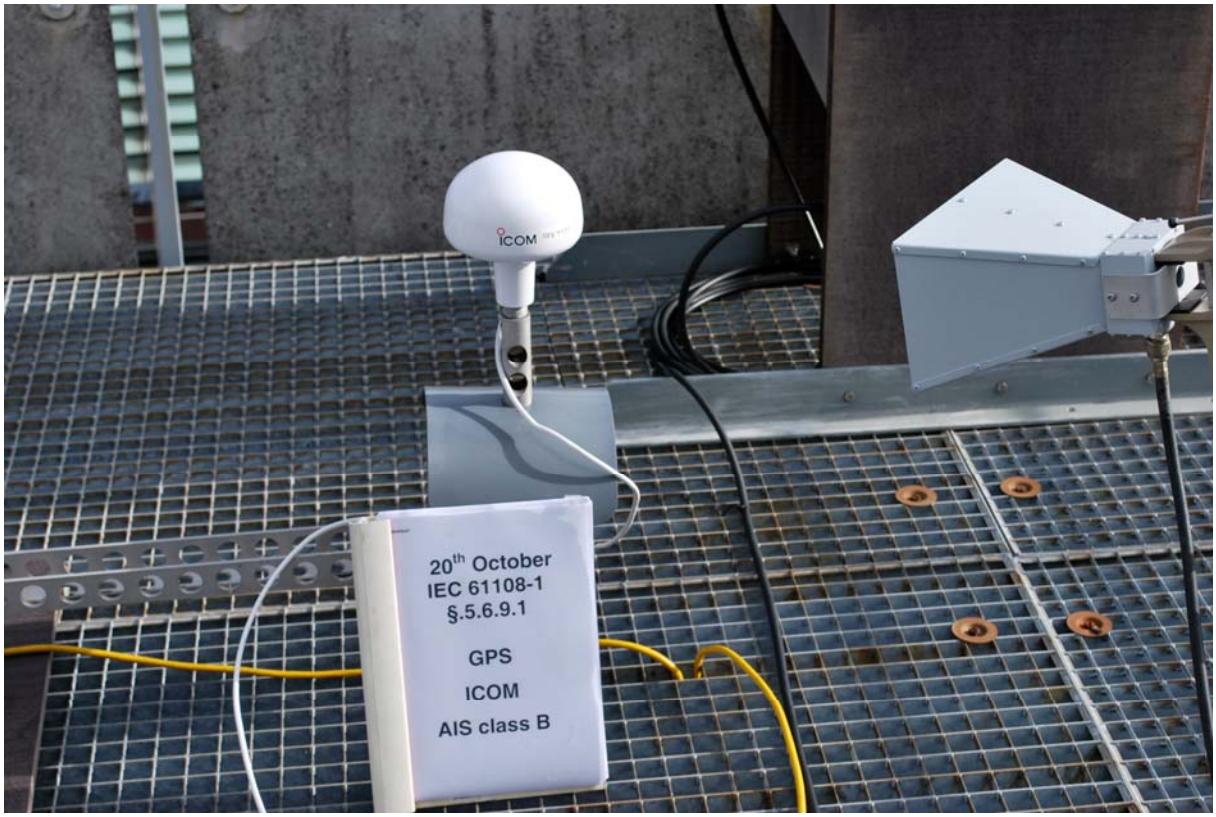
Annex C - Photos of equip m ent under test

EUT at testside, BSH Hamburg

EUT – Equipment 1 id tag

EUT – Equipment 2 id tag

EUT – L –Band interference test



EUT – S –Band interference test