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 as AIS System Component

Equipment under test:	**SRT AIS class B Transponder**
Type:	**SRT-MTB-OEM**
Applying test standard:	IEC[ISO] 61108-1 Ed.2 2003
Test Report No.:	**BSH/46162/4320358/06**
Applicant:	**Software Radio Technology Wireless House, First Avenue, Midsomer Norton, Bath, BA3 4BS Great Britain**

Hamburg, 11th August 2006

by order
Federal Maritime and Hydrographic Agency

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nach DIN EN 17025
akkreditiertes Prüflaboratorium

Deutscher Akkreditierungs Rat DAR

DAT-P-086/98-01

Translation

Deutsche Akkreditierungsstelle Technik (DATech) e.V.
Signatory of the Multilateral Agreement of EA and ILAC for the mutual recognition

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Deutschen AkkreditierungsRat

Akkreditierung

The **German Accreditation Body Technology (DATech) e.V.** confirms that the Testing Laboratory

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is competent under the terms of DIN EN ISO/IEC 17025 to carry out testing in the fields

Marine Equipment (Navigation Equipment, Radio-Communication Equipment, Life-Saving Appliances)

according to the annexed list of standards and specifications.

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DAR-Registration No.: **DAT-P-086/98-01**

Frankfurt/Main, November 11th, 2004

Dipl.-Ing. (FH) R. Egner
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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

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	NA
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	NA
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	NA
13/37-40	IEC 61108-1	4.3.11 Failure warnings and status indications	Passed
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

1.2 Equipment history

AIS class B Transponder				
Type	**SRT-MTB-OEM**	**Part No.:**	**---**	
Delivery date	**14.07.2006**	**Serial number**	**0012**	
HW Version:	**Delivery date**	**14.07.2006**	**Version no**	**----**
	Installation date	**14.07.2006**		
SW Version:	**Delivery date**	**14.07.2006**	**Version no**	**----**
	Installation date	**14.07.2006**		
SW Version:	**Delivery date**		**Version no**	
	Installation date			

GPS antenna				
Type	**SA-200**	**Part No.:**	**---**	
Delivery date	**14.07.2006**	**Serial number**	**2001827**	
HW Version:	**Delivery date**	**14.07.2006**	**Version no**	
	Installation date	**14.07.2006**		

1.3 Test environment

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

Room	**BSH 908 / WTD81 Greding Nav. Lab.**
Test engineer	**T. Möller**
Location	**Hamburg/ Greding WTD81**

Equipment no	Start of test	End of test	Test engineer
1	**14.07.06**	**10.08.06**	**T. Möller**

1.4 Legend

Result marking:

Ok	**test successful** **No colour marking**
Dev	**slight deviation, no change required** **No colour marking**
Nok	**Test of a required item was not successful, change required** **Colour marking: yellow**
Rec	**It is recommended to make a change (no formal requirement).** **Colour marking: green**
???	**temporarily, has to be clarified or discussed** **Colour marking: yellow**
NT	**Not yet tested items are marked with a blue background.**

Template for additional test notes (copy if required):

Date	**sign**	Result	Status

1.5 General observations

General observations unrelated to any paragraphs of applied test standards.

	General problems		
Date	**Item**	**Remark**	**Result**

Functional Tests

1.6 IEC 61108-1

No. of test	IEC 61108-1	Requirement/Condition	Result	Note
	4	**Minimum Performance Standards**		
1	**4.1**	**Object** **compliance with IEC 61162** **compliance with IEC 60945**	**Not tested**	
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.**	**Passed**	**EUT is an embedded GPS-Receiver in an AIS Class B Transponder** **See also test results under test no. 16.**
	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.**	**Passed**	**EUT is an embedded GPS-Receiver in an AIS class B Transponder** **See also test results under test no. 16**

	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.**	**Passed**	**All requirements are met as described in the manufacturers documentation.** **See also test results under test no. 17.**

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).**	**Passed**	**Not available in an AIS System**

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.**	**Passed**	**See test results under test no. 19 – 21.**
	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.**	**Passed**	**See test results under test no. 22 and 23.**
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.**	**Passed**	**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**		
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.**	**Passed**	**See test results under test no. 28.**
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.**	**Passed**	**See test results under test no. 29.**
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.**	**Passed**	**See test results under test no. 30 and 31.**

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.**	**Passed**	**NOTE Condition a) is equivalent to exposing the antenna to radiation from an INMARSAT-A or B transmitter at 10 m distance along the bore sight.** **See test results under test no. 32.** **NOTE This condition is approximately equivalent to exposing the antenna to radiation from a 60 kW 'S' band marine radar operating at a nominal 1,2 µs pulse width at 600 pulses/s using a 4 m slot antenna rotating at 20 r/min with the GPS antenna placed in the plane of the bore site of the radar antenna at a distance of 10 m from the centre of rotation.** **See test results under test no. 33.**
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.**	**Passed**	**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.**

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.**	**Passed**	**NOTE** **Differential data is received by the AIS system via VHF, AIS message 17.** **See test results under test no. 36.**
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;**		**See test results under test no. 37 and 38.**
	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.**	**Passed**	**NOTE a2) For craft meeting the HSC code, an new position solution at least every 0.5 s is recommended.** **See test results under test no. 37 and 38.**

	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**	**NOTE** **For AIS RAIM is indicated by RAIM flag contained in AIS Message 18.** **RAIM flag indicates RAIM functionality as available and in use.** **See test results under test no. 39 and 40.**
	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**	**NA**	

		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.**	**passed**	**DGPS integrity indication is presented in AIS msg. 18. Test performed and found ok.**
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.**	**NA**	
	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**	**See test results under test no. 41.**

		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**	**See test results under test no. 41.**
	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.**	**NA**	
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.**	**Passed**	**See test results under Test no. 43 and 44.**
	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**	**Equipment and manufacturer's documentation inspected and found ok.**
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**	**Equipment and manufacturer's documentation inspected and found ok.**
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.**	**NA**	

	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.**	**Passed**	**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.**
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.**	**Passed**	**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 D-GPS mode**
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.**	**Passed**	**The EUT antenna was mounted in 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/D-GPS mode**

	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**	**Accuracy requirements are met - see Annex B for printouts of the measurements for dynamic accuracy in GPS mode.**

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.**	**Passed**	**Accuracy requirements are met - see Annex B for printouts of the measurements for dynamic accuracy in D-GPS mode.**
	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.**	**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.**	**Passed**	**For test results see Annex B of this report**
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**	**For test results see Annex B of this report**

	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.**	**Passed**	**The EUT was tested in a simulator (see Annex B)**
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.**	**Passed**	**The EUT was tested in a simulator (see Annex B).**
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.**	**NA**	**Documentation inspected and found ok.** **EUT received AIS testtransmissions (AIS msg.17) and indicated reception and use of differential data. Ok.**

	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.**	**NA**	
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 GPS 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**	**Passed**	**EUT received AIS testtransmissions (AIS msg.17) and indicated reception and use of differential data.**
	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.**		
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** **2) the "safe" status is indicated.**	**NA**	

		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.**	**NA**	

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**	**This test was performed by using a car mounted D/GPS reference system (see Annex B).**
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.**	**NA**	

	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.**		
	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.**		
	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.**		

	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.**		
	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.**		
	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.**		

	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.**		
	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**		**Interference was applied in a simulated environment (see Annex B).**

	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.**		
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.**	**Passed**	**This test was performed by using a simulator (see Annex B).**
	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.**		
	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**		

	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).**		
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.**	**Passed**	**This test was performed by using a simulator (see Annex B).**
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)**	**Passed**	

Annex A - Test equipmen t

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'**	**Static accuracy testing**
Antenna angular movement driven support	**Nil**	**N/a**	**Angular movement of GPS antenna during static precision test**
GPS Simulation Unit at WTD 81 Greding, Bavaria, Germany	**SPIRENT Communications** **Hardware: Typ STR2760, S/N 160 & S/N 161** **Software: SimGEN Ver. 7.21 SR01 for Open VMS**	**Under constant calibration control at WTD 81 Greding** **Function tests performed successfully according documented test procedures before performance of tests**	**Dynamic accuracy,; Sensitivity and dynamic range; Typical interference**
INMARSAT- M communication device	**QUFC 911 901/1 SN 00354**	**N/a**	**L-Band induction**
Radar-Device Furuno FR 2135S		**N/a**	**S-Band induction**
Narda Electromagnetic Radiation Monitor	**Model 8616**	**Calibration Certificate E-38743-02-10**	**Induced Power of L-Band**

Reference position

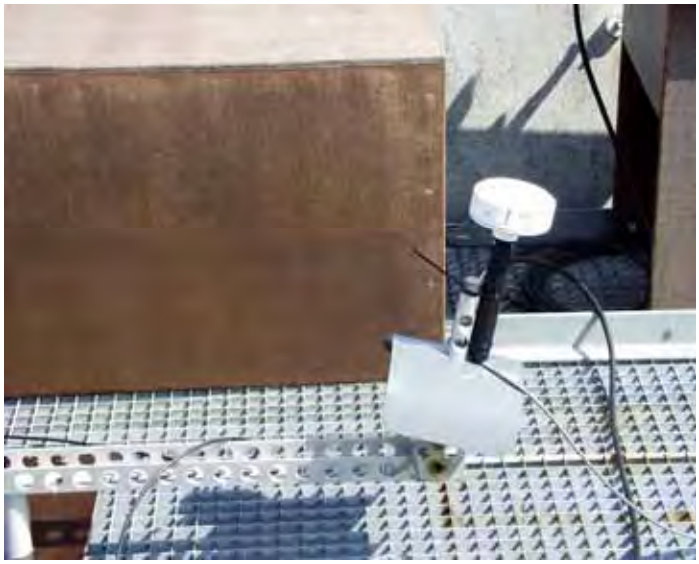
Made by FREIE UND HANSESTADT HAMBURG
Vermessungsamt –VA311-

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 = ± 0.05 m

A.2 Documentation of test equipment

A.2.1 Antenna angular movement driven support

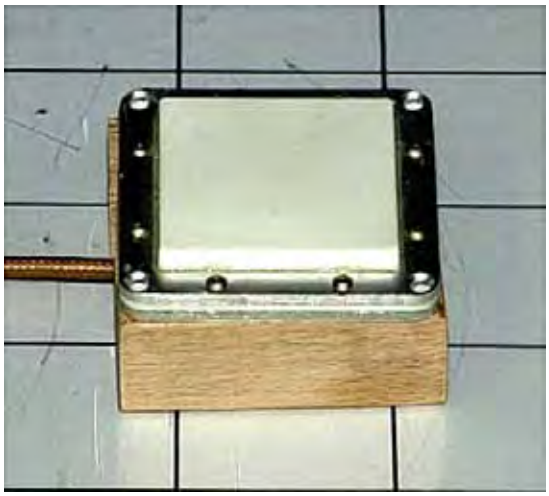


Mechanical arrangement
The mechanical arrangement designed for the required movement of the antenna of the EUT.
Used for testing of §5.6.4.2, IEC61108-1

A.2.2 GPS Simulation Unit at WTD 81

Spirent GPS-Simulator at WTD81, Greding Bavaria

GPS- Signal transmitting antenna



Reference antenna, front side

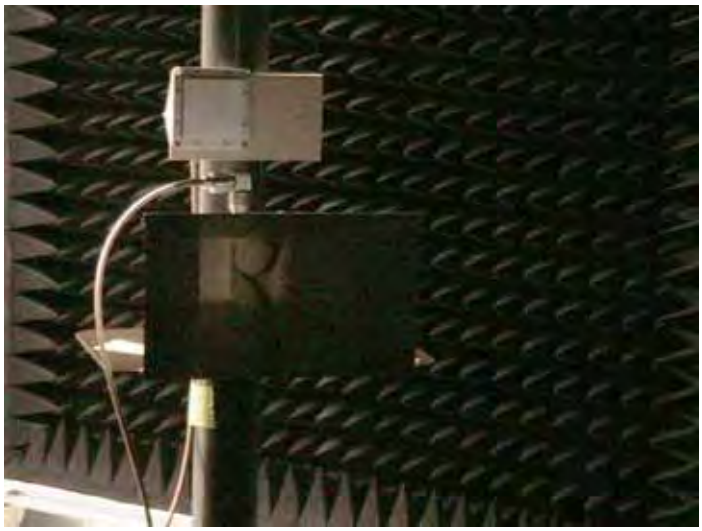
Reference antenna, back side

Calibrated attenuation cell, connector side

GPS test box, exterior view

GPS test box, interior view

Arrangement of GPS- and noise/ interference transmitting antennas



A.2.3 Inmarsat communication device

Specification of Inmarsat-M used for L-Band Test

Manufacturer:	**NERA**
Model:	**Saturn Mm Marine**

Specifications:

System :	
Tx Freq.	**1626.5 – 1646.5 MHz**
EIRP	**27/21 dBW**
Rx Freq.	**1525.0 – 1545.0 MHz**
Channel spacing	**10 kHz**
G/T	**-10 dB/K**
Antenna	**Stabilized flat plane array**

Electromagnetic compatibility:

Radiated	**EN 55022 class B**
Conducted	**EC 801**

Interfaces:	
Ext. tel/fax outlets	**5 x RJ11, 2-wire with echo cancelling and touch-tone dialling**
Fax	**CCITT G3 at 2400 bps**
Data	**D-sub, 25-pin fem., 2400 bps, RS-232**
Hayes AT compatible	
PC	**D-sub, 9-pin fem., RS-232**
Printer	**D-sub, 9-pin male, RS-232**
Gyro	**Synchro, step-by-step**

(Basic system incorporates built-in fluxgate compass)

Navigator	**NMEA 0183**	
Power Supply	**10 - 34 VDC**	**(90-276 VAC optional)**
Power Consumption	**75 W**	

A.2.4 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.2.5 Narda electromagnetic radiation monitor

Specification of Radiation Monitor

Manufacturer:	**narda**	
Model:	**Electromagnetic Radiation Monitor Model 8616**	
Specifications:		
Dynamic range	**30 dB**	
Full scale ranges (mW/cm^2)	**0-0.2; 0-2; 0-20, and 0-1; 0-10; 0-100**	
Accuracy:	**± 3 %**	
Response Time (approx.)	**1 sec in fast position, 3 sec in slow position**	
Model:	**Probe 8621B**	
Specifications:		
Frequency sensitivity	**13 to 200 MHz**	**0.5 dB**
	10 to 300 MHz	**2 dB maximum total deviation**
	1 to 12 GHz	**± 0.75 dB**
	0.85 to 16 GHz	**+ 0.75 dB – 1 dB**
	0.3 to 18 GHz	**+ 0.75 dB – 3 dB**
	0.3 to 2 GHz	**+ 0.75 dB – 4.5 dB**
CW overload rating	**300 mW/cm^2**	
Peak Power	**60 W/cm^2**	

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

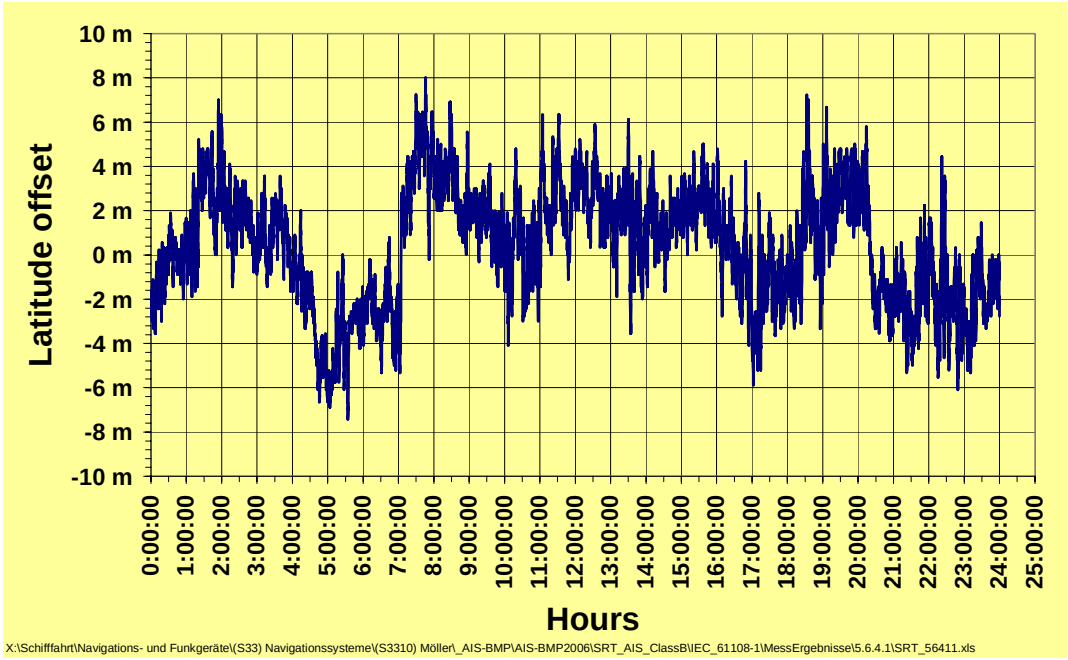
Period of position fix measurements:	approx. 24 h
Position fix measurements :	approx. 86600
Accuracy:	HDOP ≤ 4 (or PDOP ≤ 6)

Test results
All deviations of measured positions from reference position are <±13 m (95 %).
2 sigma value of position data: 5.92m.

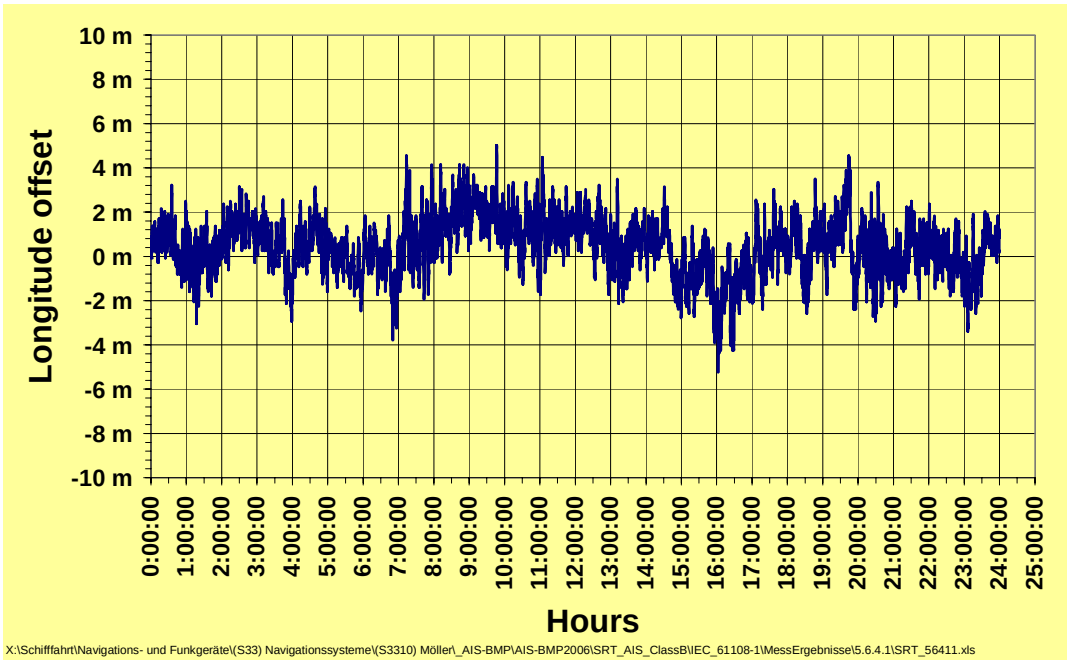
Test result: Passed

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

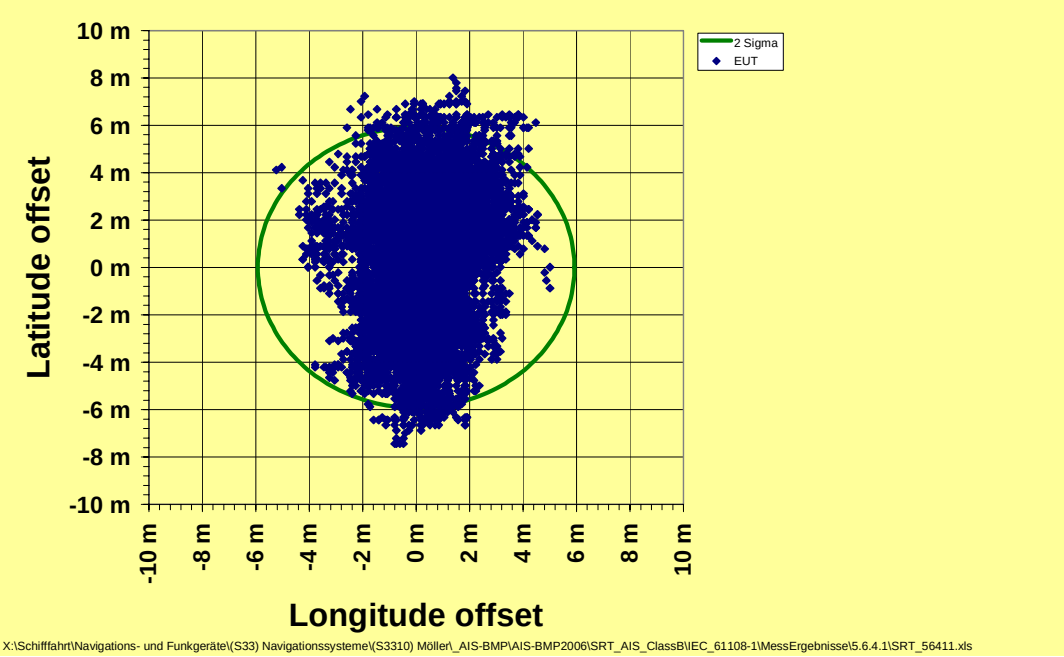
Latitude offset – GPS static accuracy



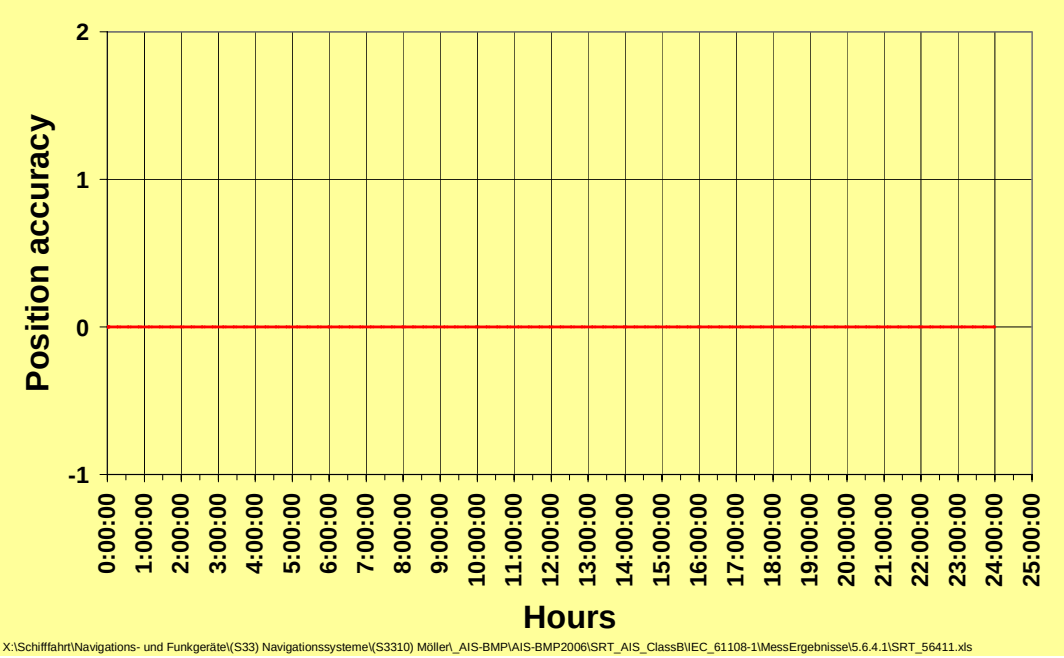
Longitude offset – GPS static accuracy



Position offset – GPS static accuracy



Position accuracy



B.1.2 §5.6.4.1.2 Static accuracy – 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 positio 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 GPS broadcast in accorance with ITU-R M.823.

Conditions of tests performed

Period of position fix measurements:	approx. 24 h
Position fix measurements :	approx. 88000
Accuracy:	HDOP ≤ 4 (or PDOP ≤ 6)

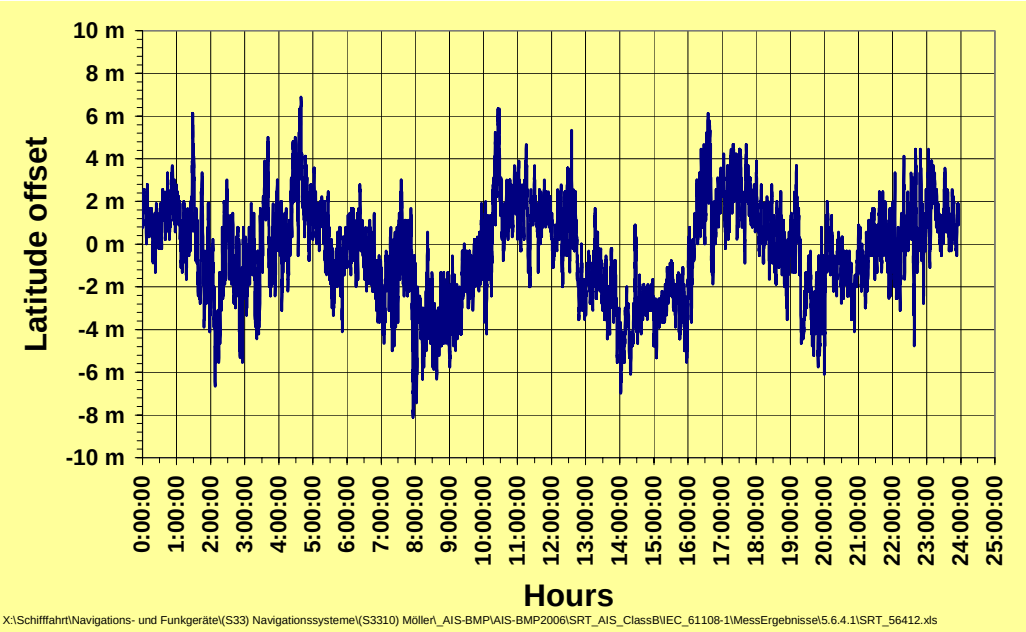
Test results

All deviations of measured positions from reference position are <±10 m (95 %).
2 sigma value of position data: 4.94m.

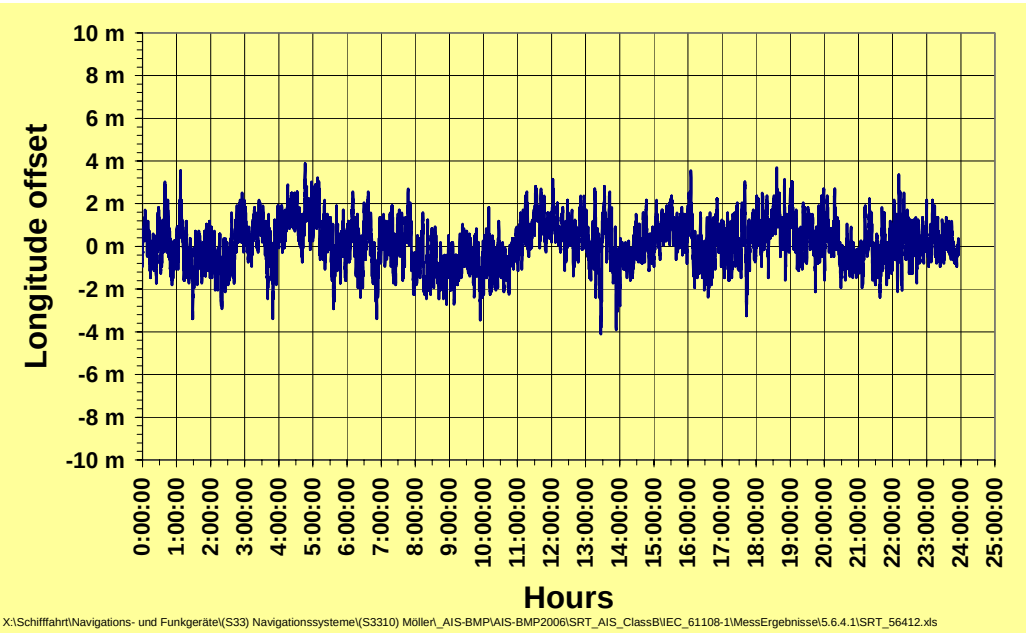
Test result: Passed

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

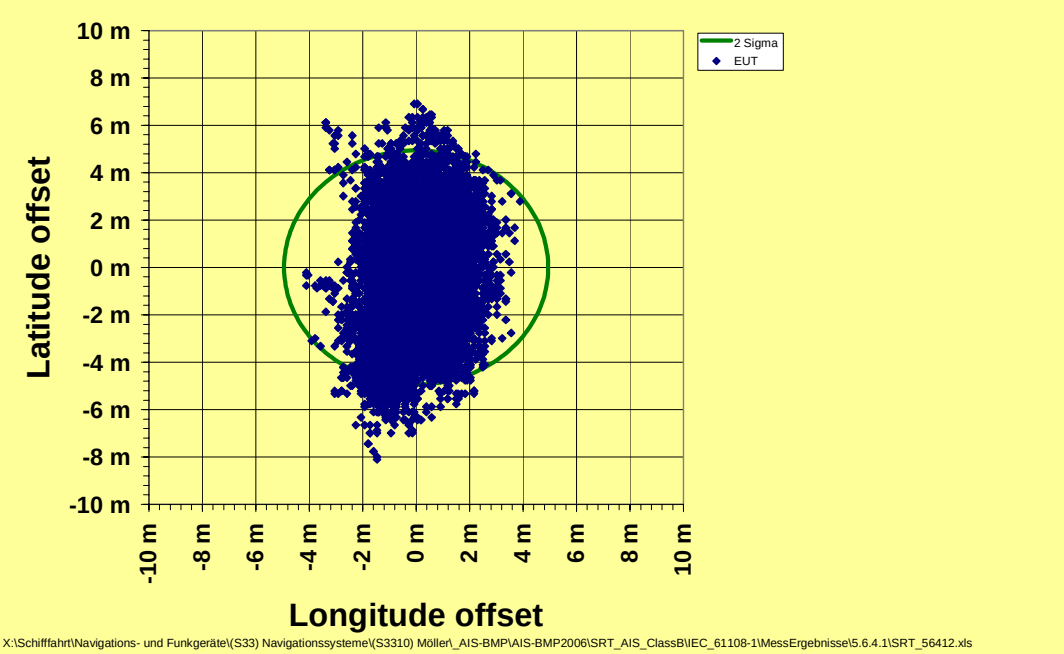
Latitude offset – differential GPS static accuracy



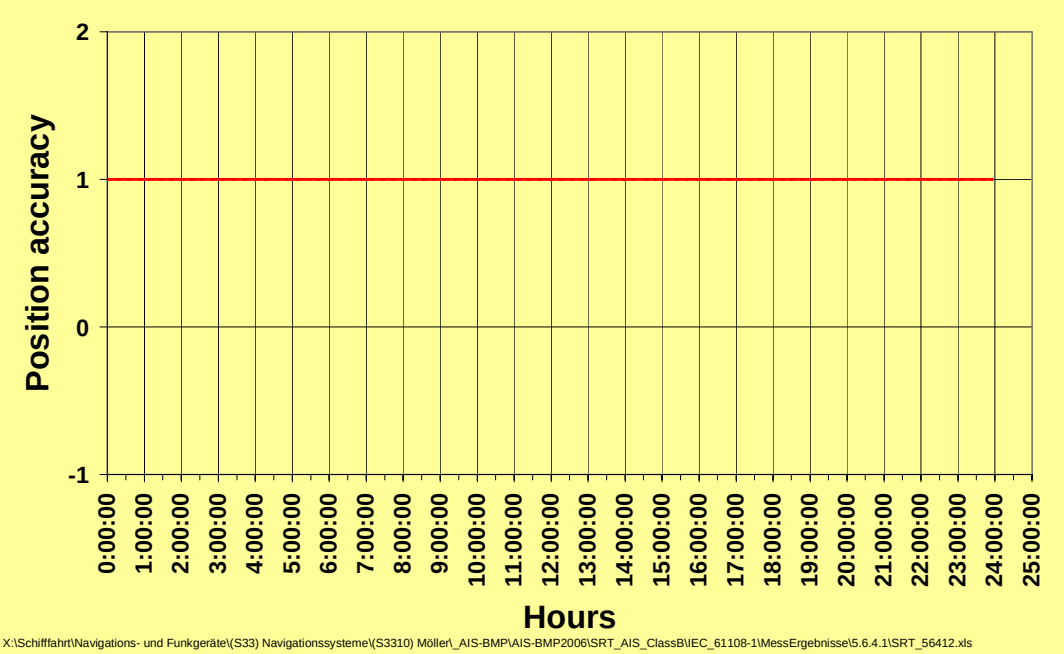
Longitude offset – differential GPS static accuracy



Position offset – differential GPS static accuracy



Position 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 (see IEC 60721-3-6) during the duration of the test.

Conditions of tests performed for § 5.6.4.2.1

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

Period of position fix measurements:	approx. 24 h
Position fix measurements :	88000
Accuracy:	HDOP ≤ 4 (or PDOP ≤ 6)

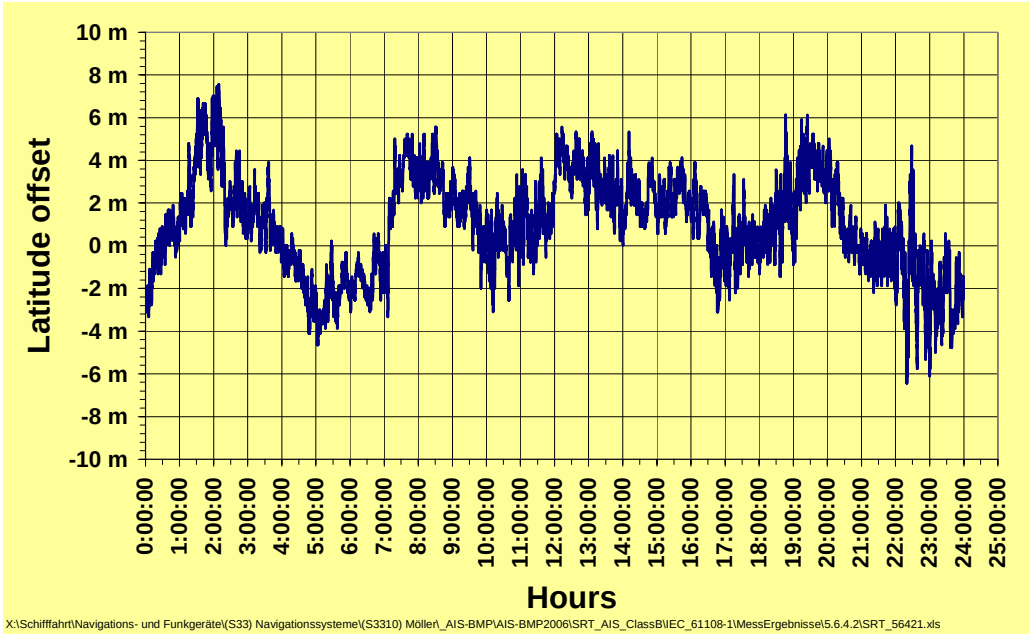
Test results for § 5.6.4.2.1

All deviations of measured positions from reference position
are <±13 m (95 %).
2 sigma value of position data: 5.46m.

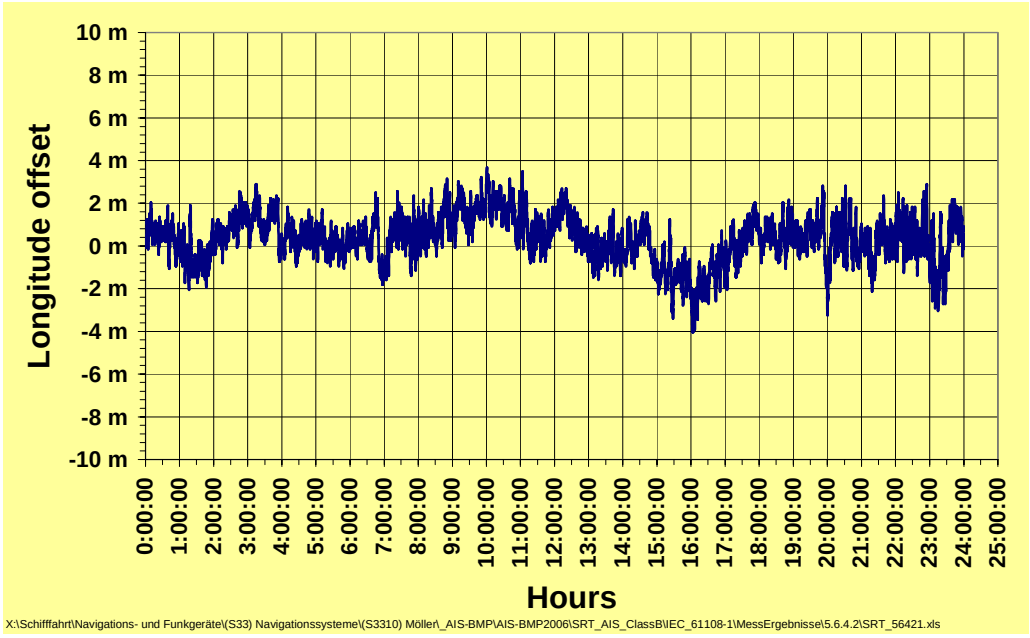
Test result: Passed

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

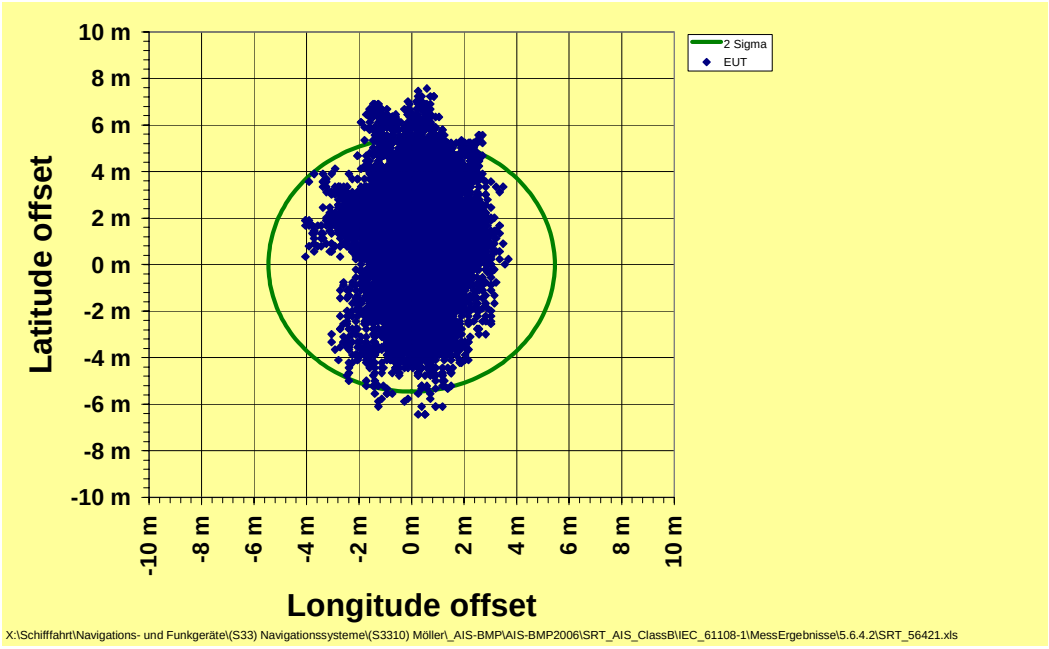
Latitude offset – Angular movement of antenna, GPS



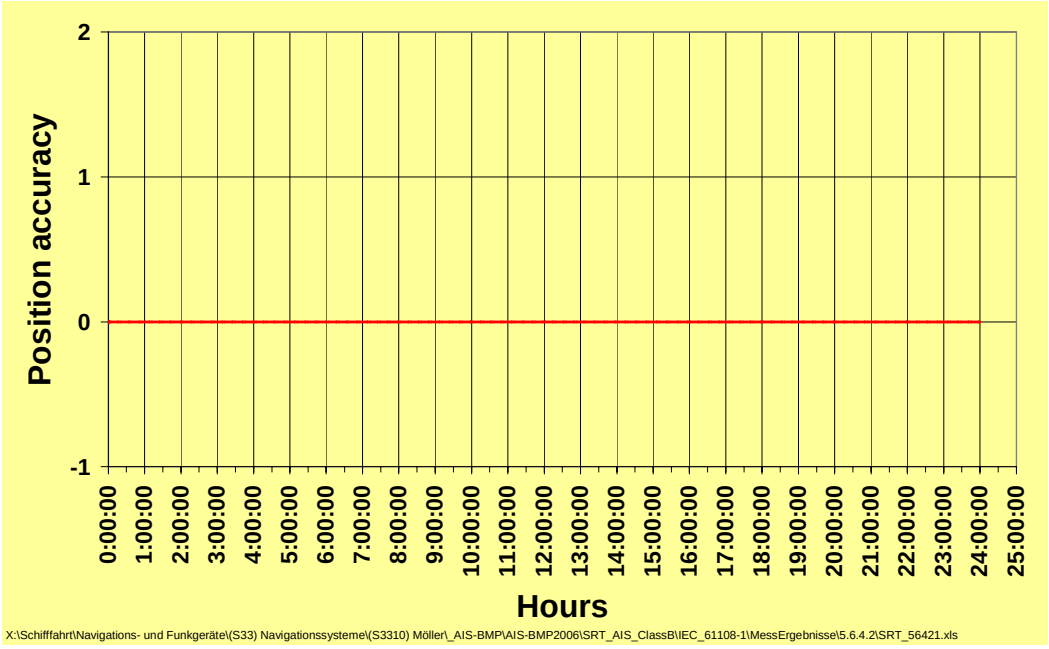
Longitude offset – Angular movement of antenna, GPS



Position offset – Angular movement of antenna, GPS



Position accuracy flag



B.2.2 § 5.6.4.2 Angular movement of the antenna – DGPS

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 (see IEC 60721-3-6) during the duration of the test.

Conditions of tests performed for § 5.6.4.2.2

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

Period of position fix measurements:	approx. 24 h
Position fix measurements :	88000
Accuracy:	HDOP ≤ 4 (or PDOP ≤ 6)

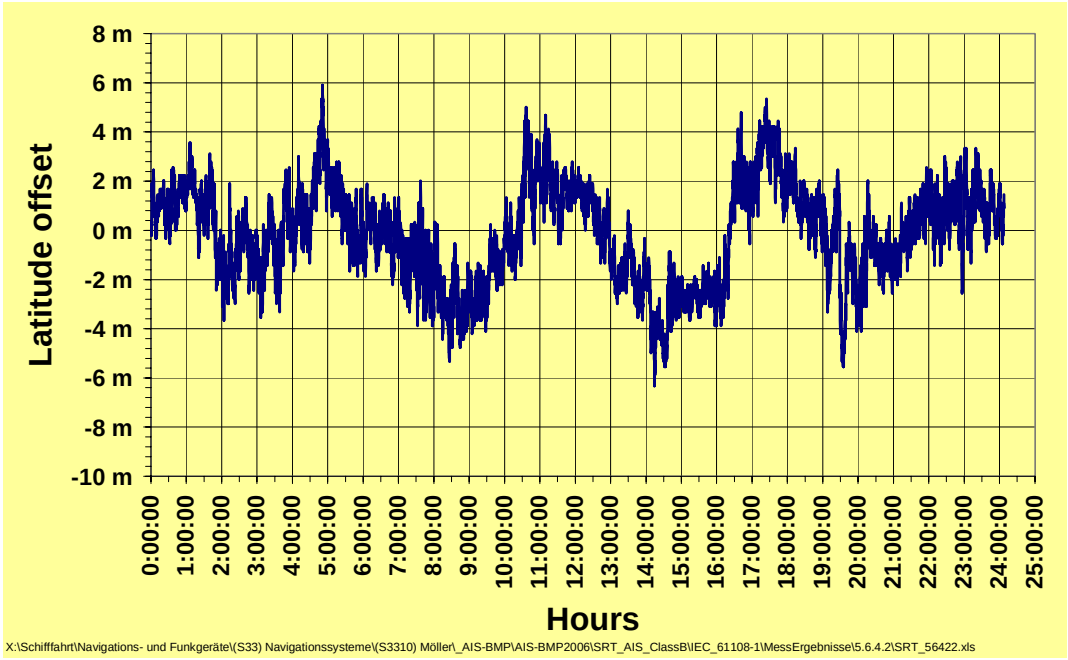
Test results for § 5.6.4.2.2

All deviations of measured positions from reference position
are <±10 m (95 %).
2 sigma value of position data: 4.29m.

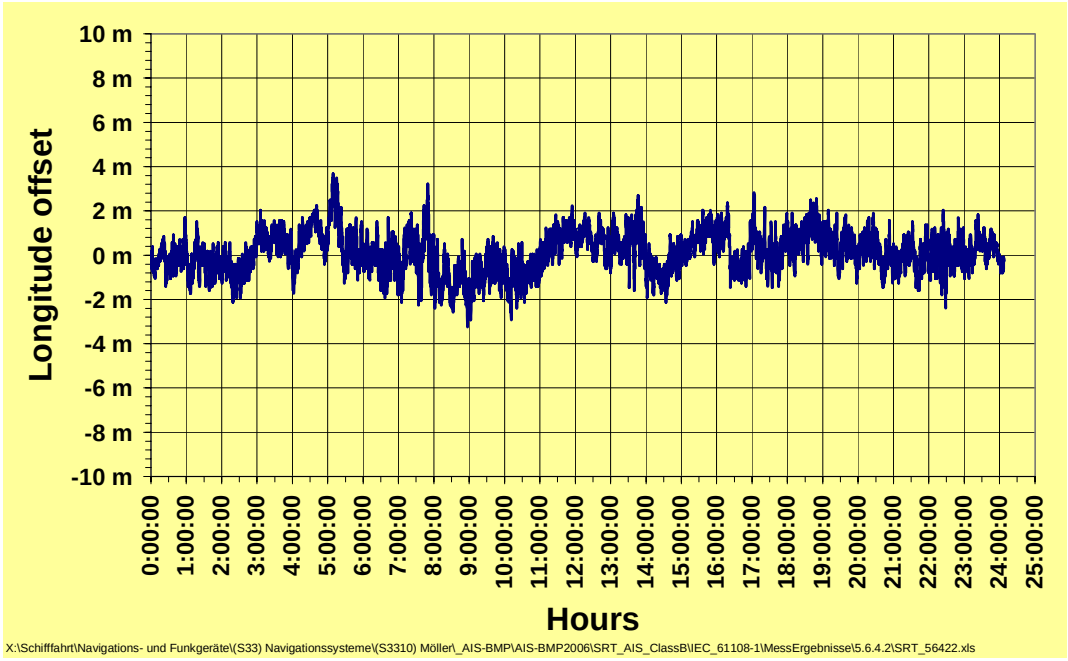
Test result: Passed

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

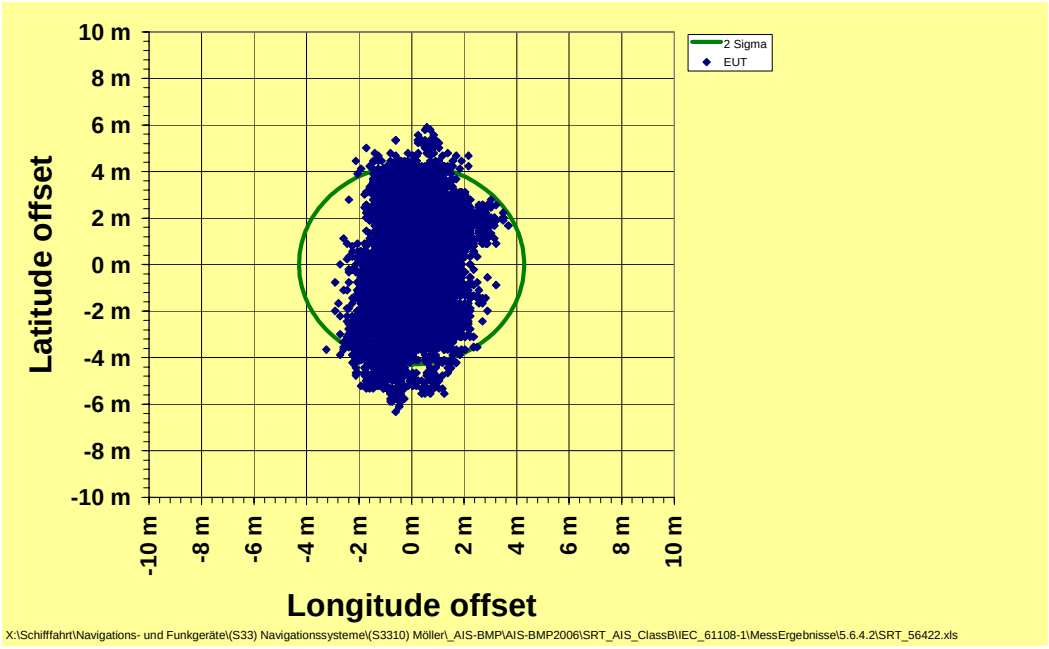
Latitude offset – Angular movement of antenna, DGPS



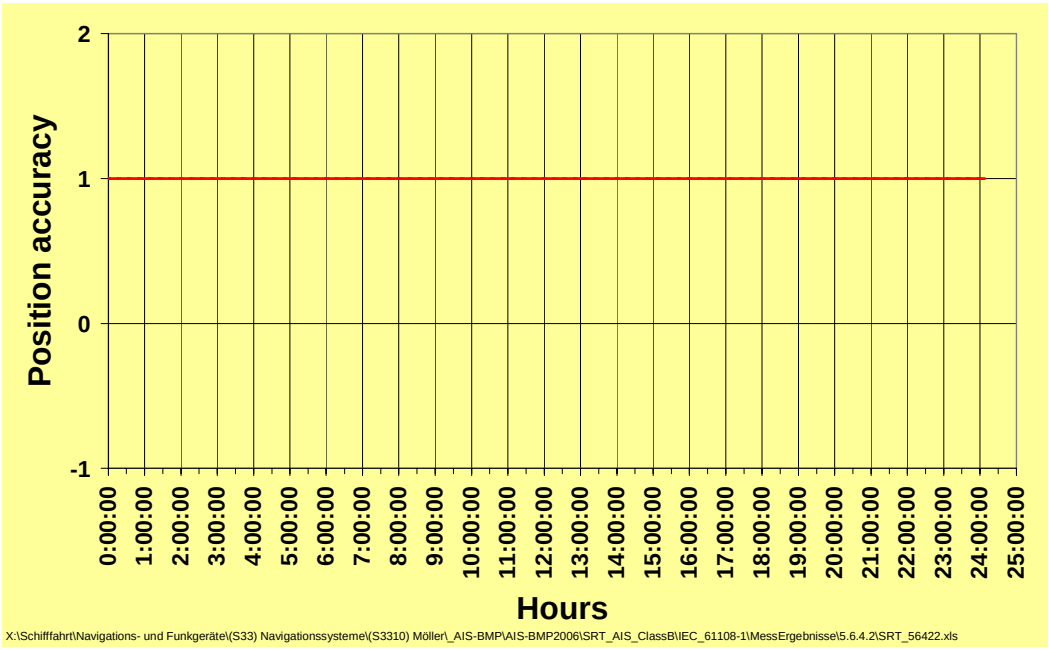
Longitude offset – Angular movement of antenna, DGPS



Positon offset – Angular movement of antenna, DGPS



Position accuracy



B.3 § 5.6.4.3 Dynamic accuracy

Reference position WTD 81 Greding
Made by GPS-Simulator

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

Accuracy of survey = ± 0 cm

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 by using a simulator

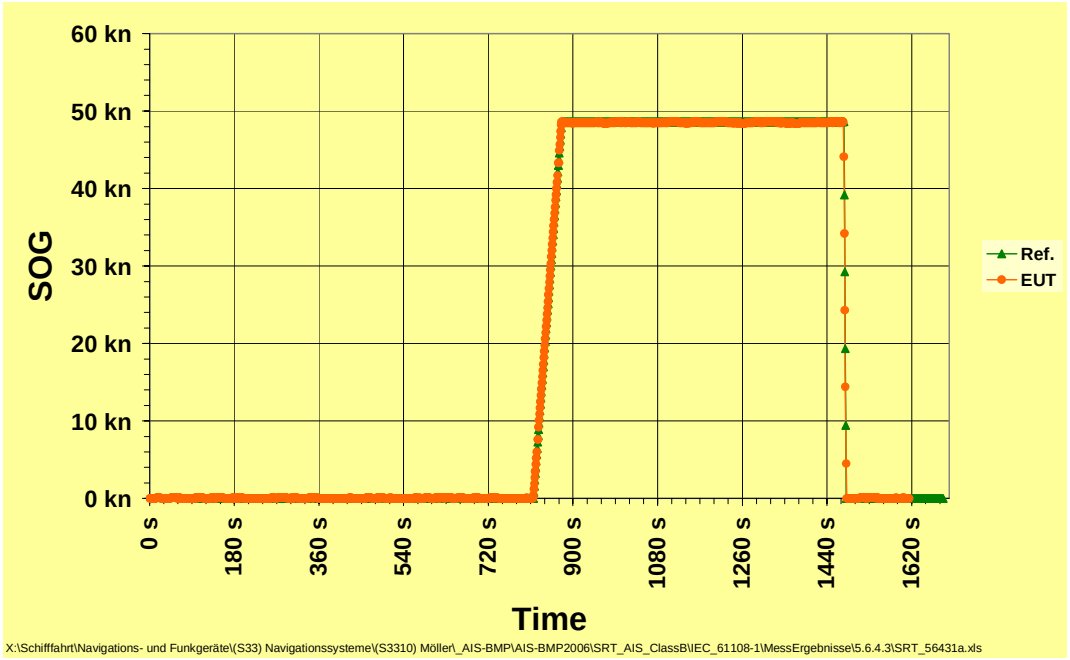
Test results

All positions offsets are <± 13 m.

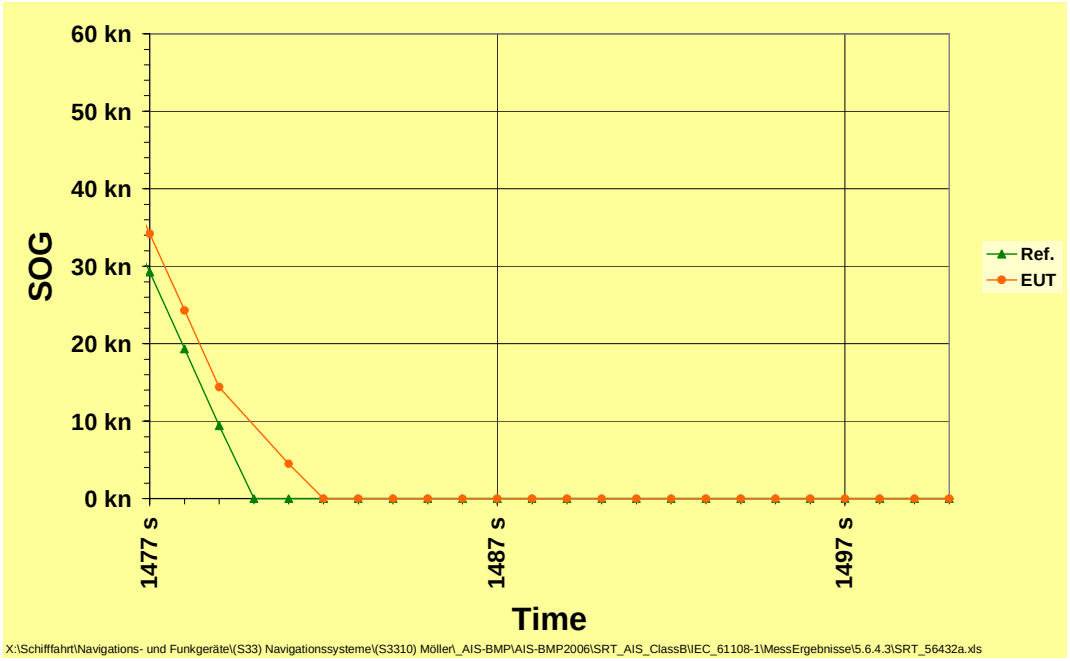
Test result: Passed

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

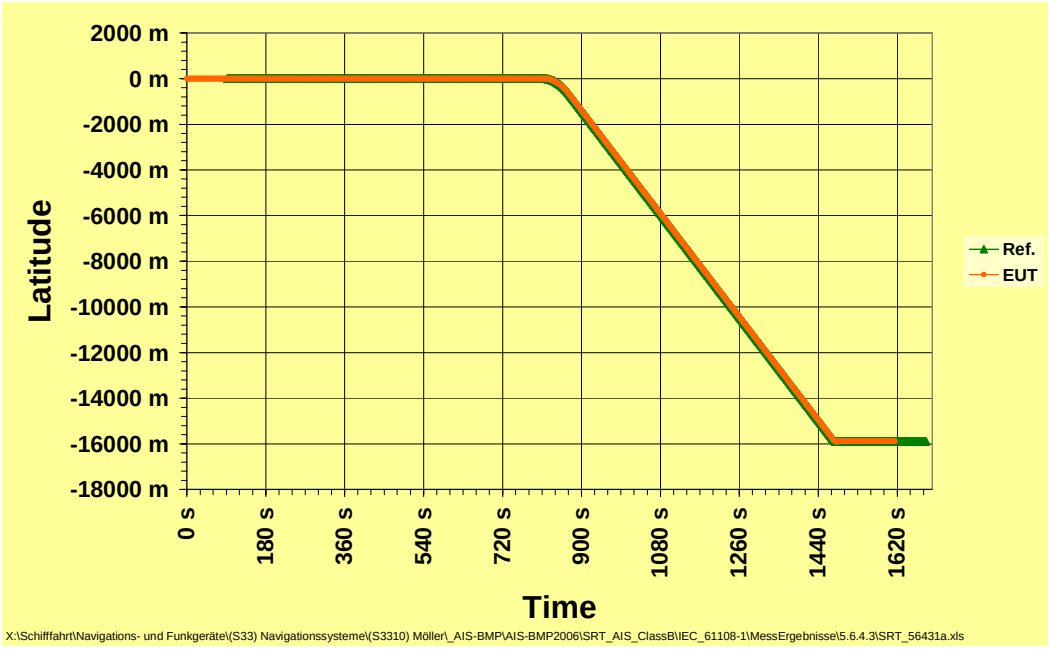
Speed over ground (SOG)



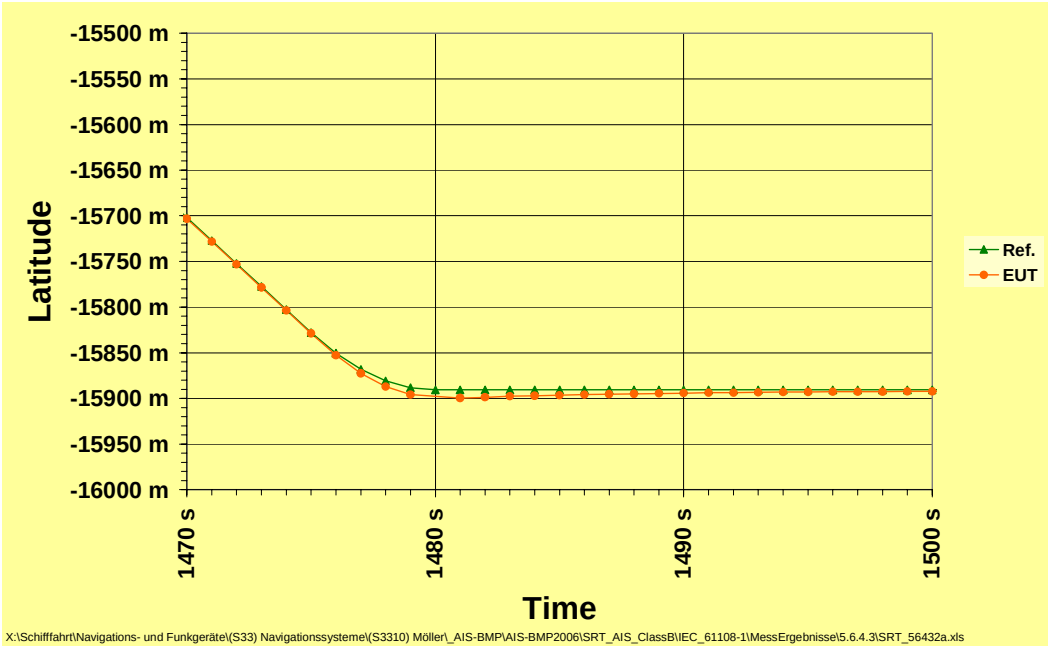
Speed over ground, coming to rest position



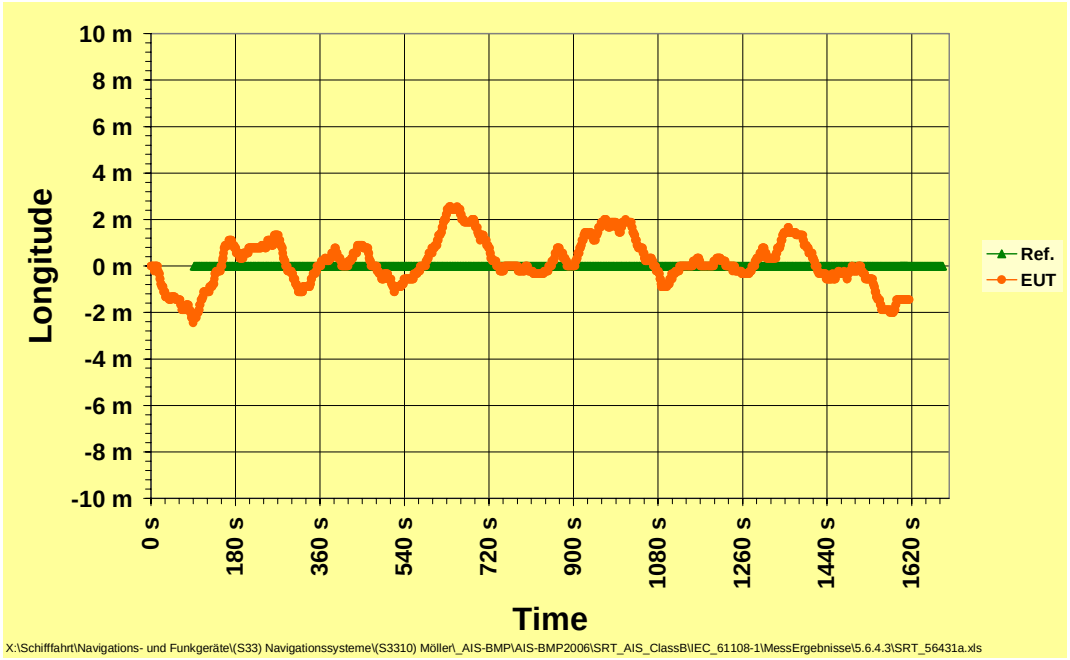
Latitude



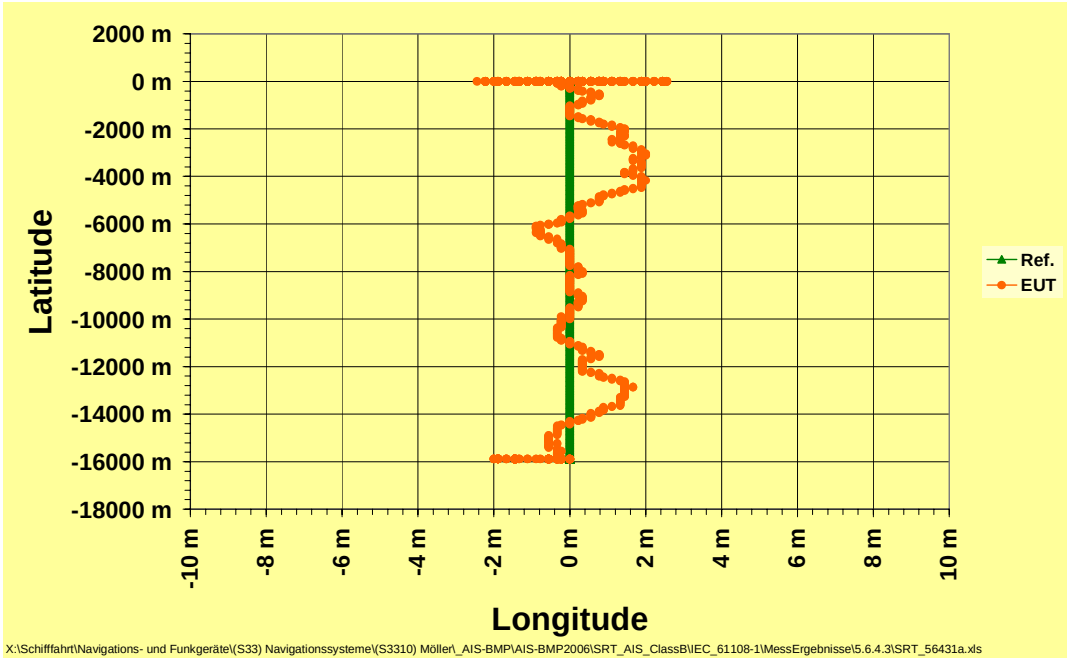
Latitude, coming to rest position



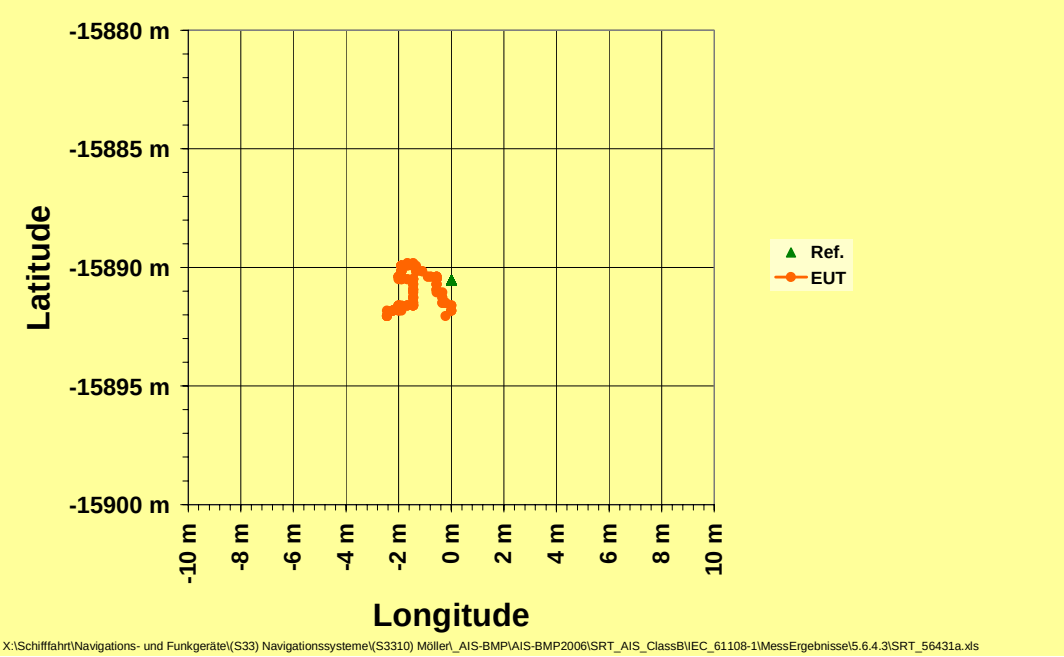
Longitude



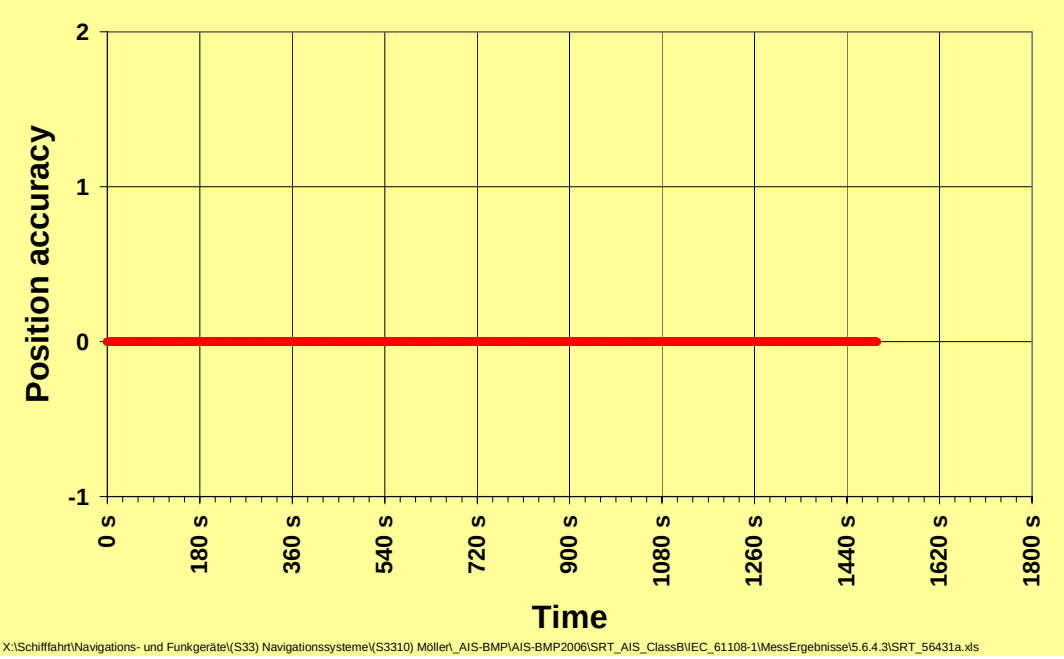
Position



Position offset, coming to rest position



Position accuracy



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 by using a simulator

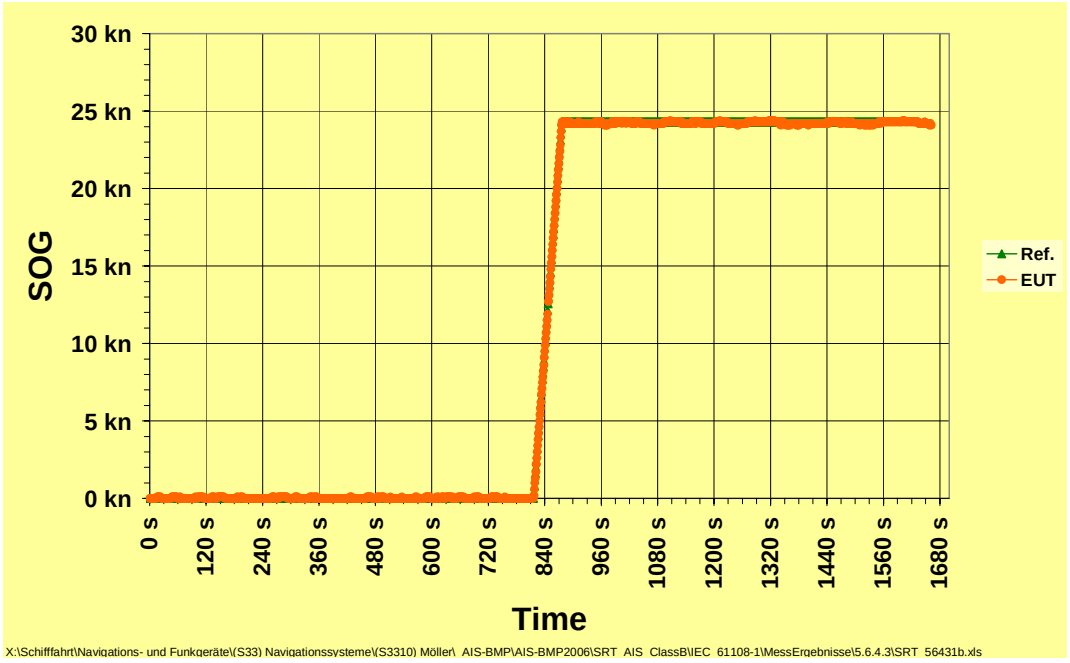
Test results

All positions offsets are within a lane of 30 m.

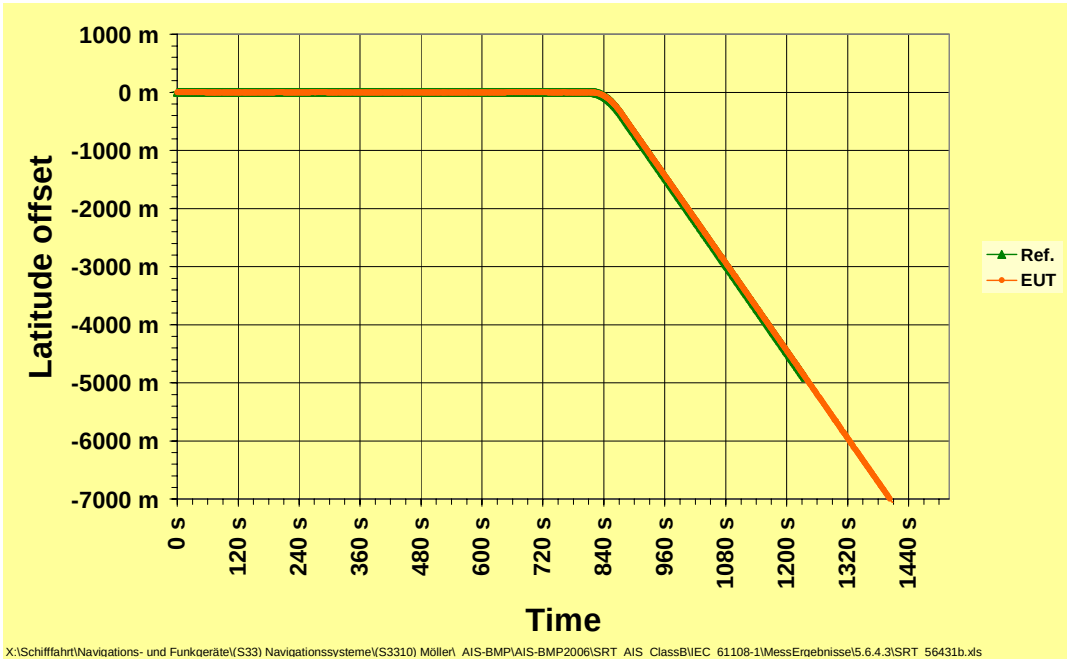
Test result: Passed

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

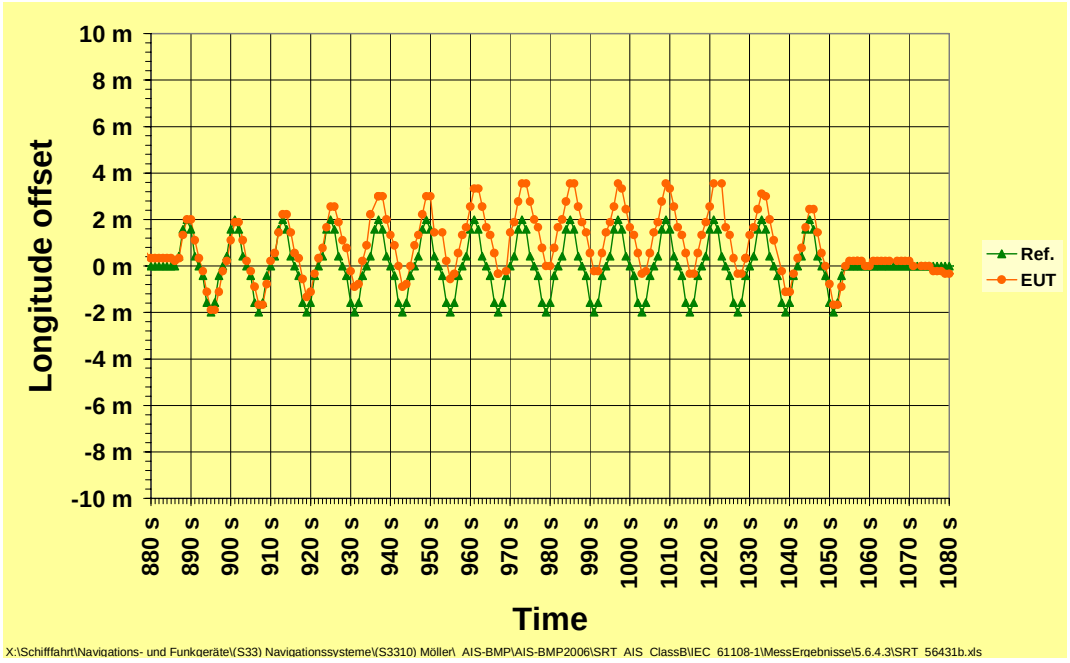
Speed over ground (SOG) vs. time



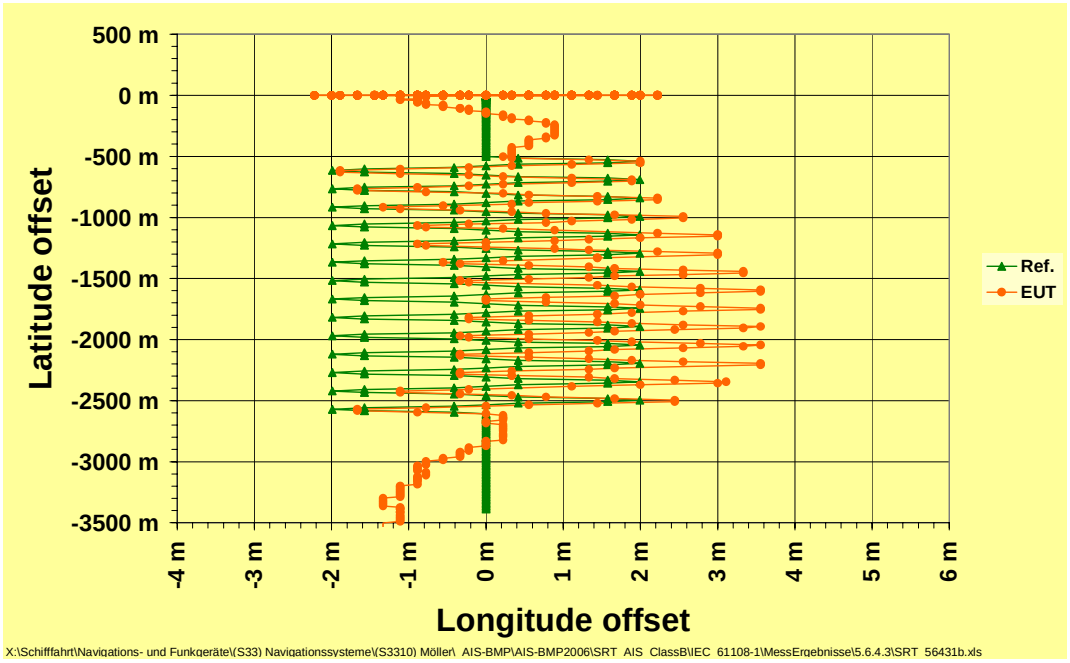
Latitude vs. time



Longitude vs. time



Position



B.3.3 § 5.6.4.3.2 Differential 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 ± 10 m from the true position at rest an the indicated position shall settle to within ±2 m of the rest position indication within 10 s of coming to rest.

Conditions of tests performed

Tests performed by using a simulator

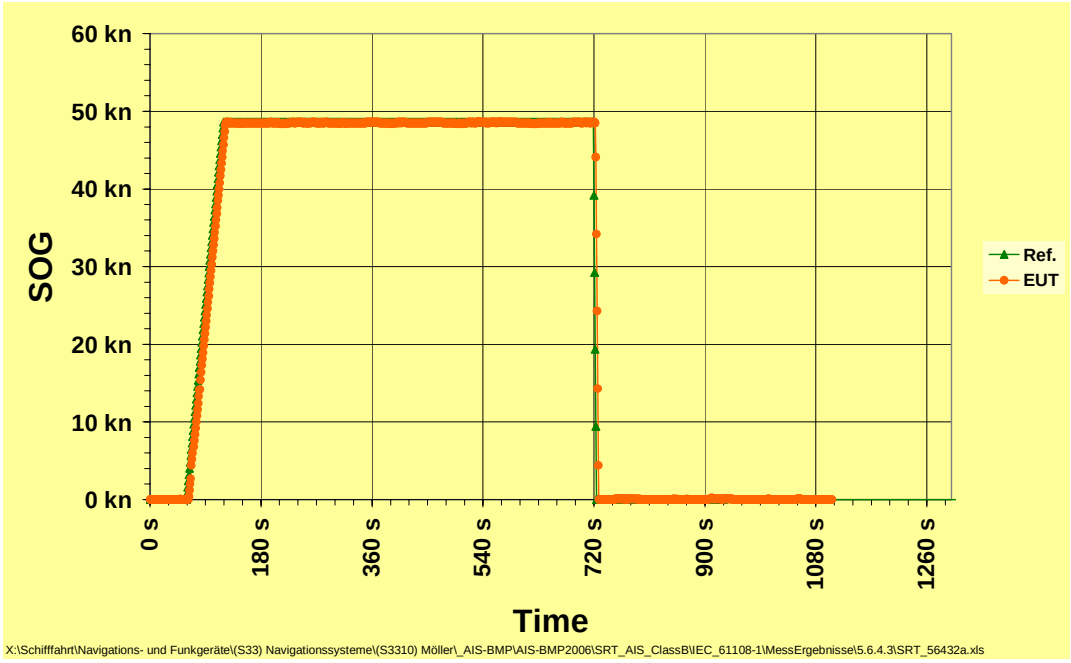
Test results

All positions offsets are <± 10 m and position variation within ±2 m.

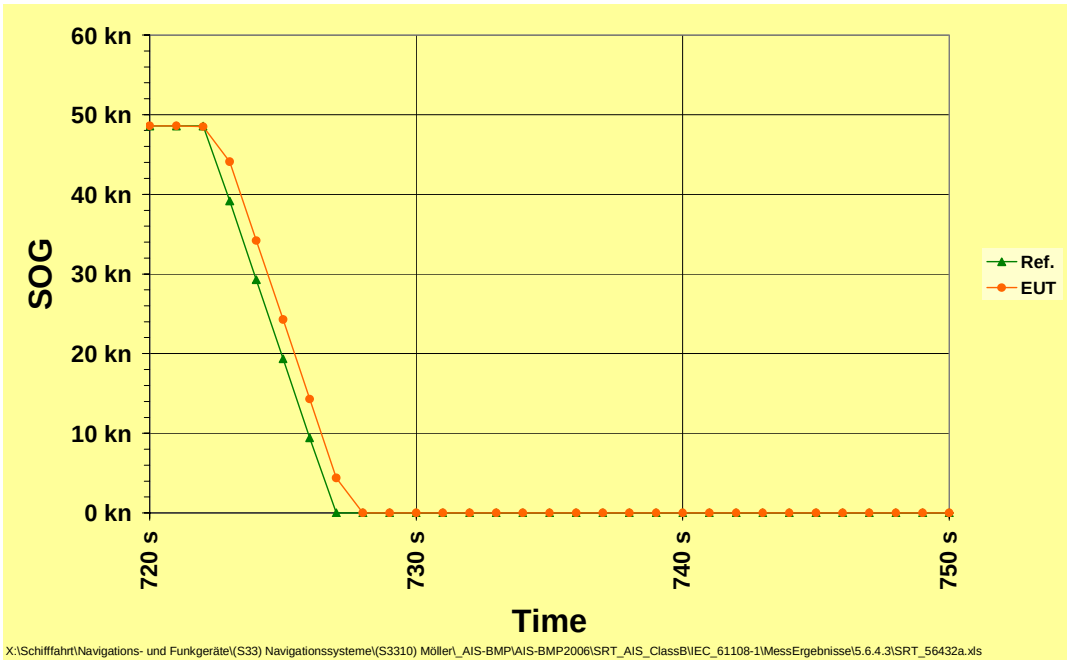
Test result: Passed

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

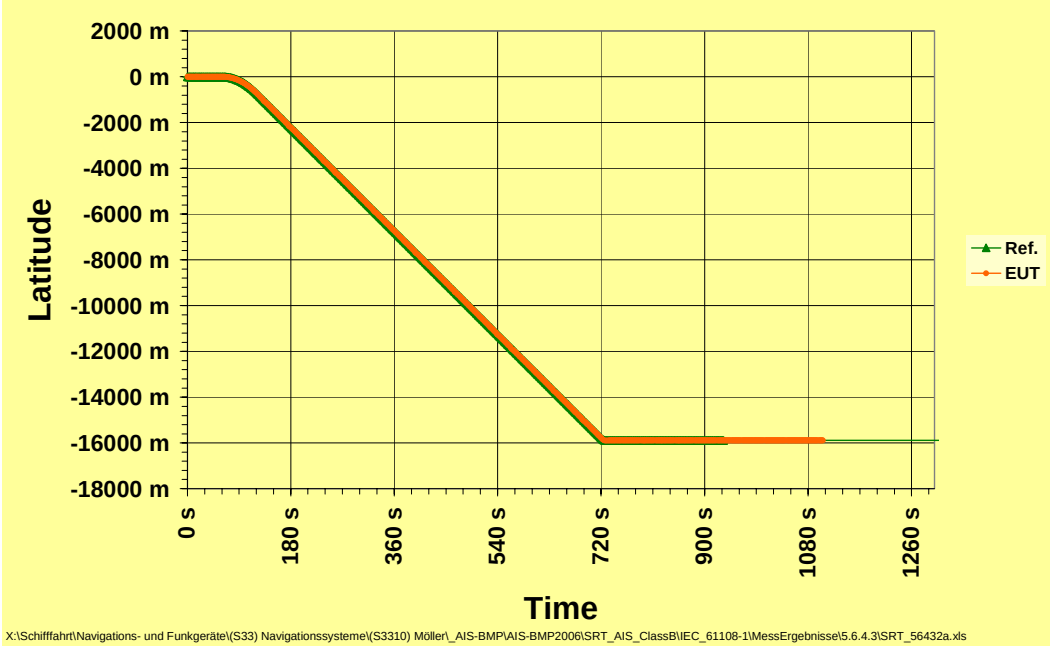
Speed over ground (SOG) vs. time



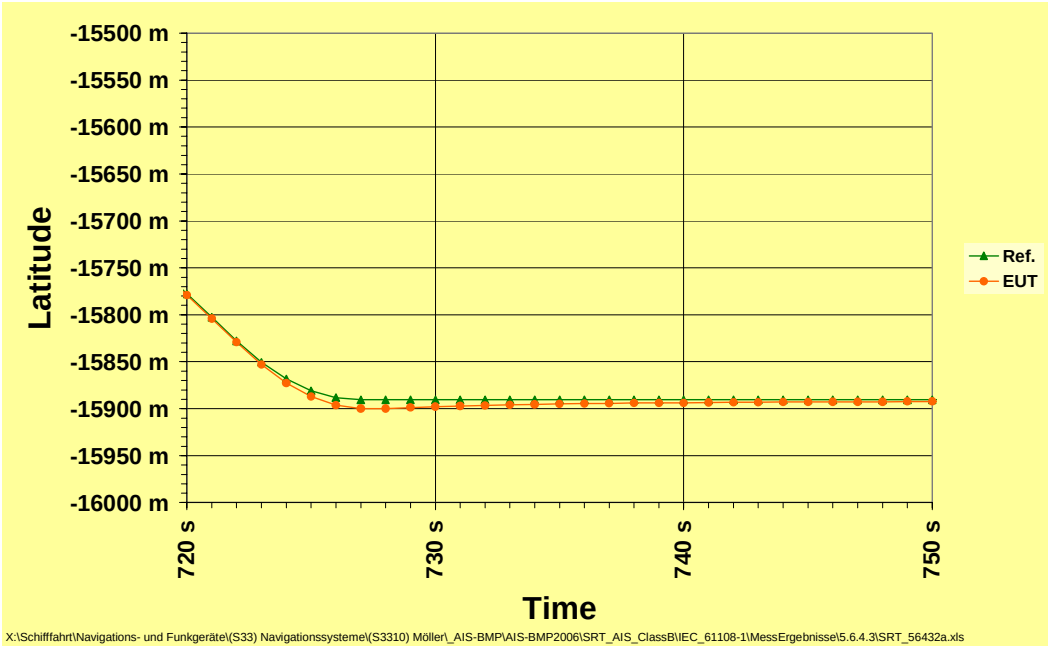
Speed over ground (SOG) vs. time, detail



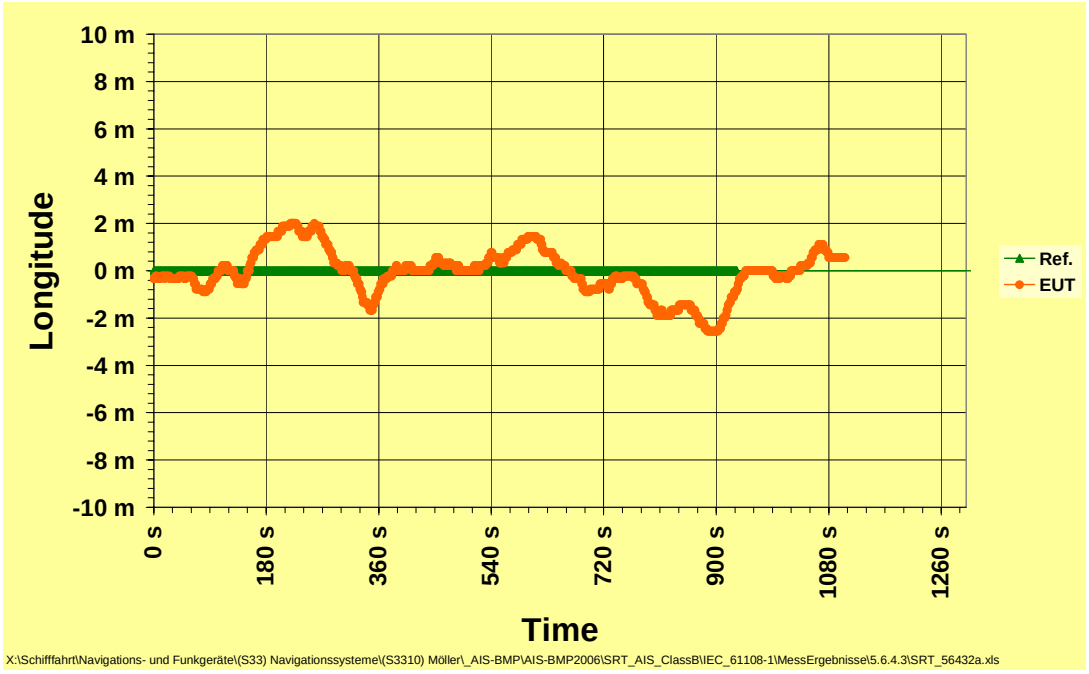
Latitude vs. time



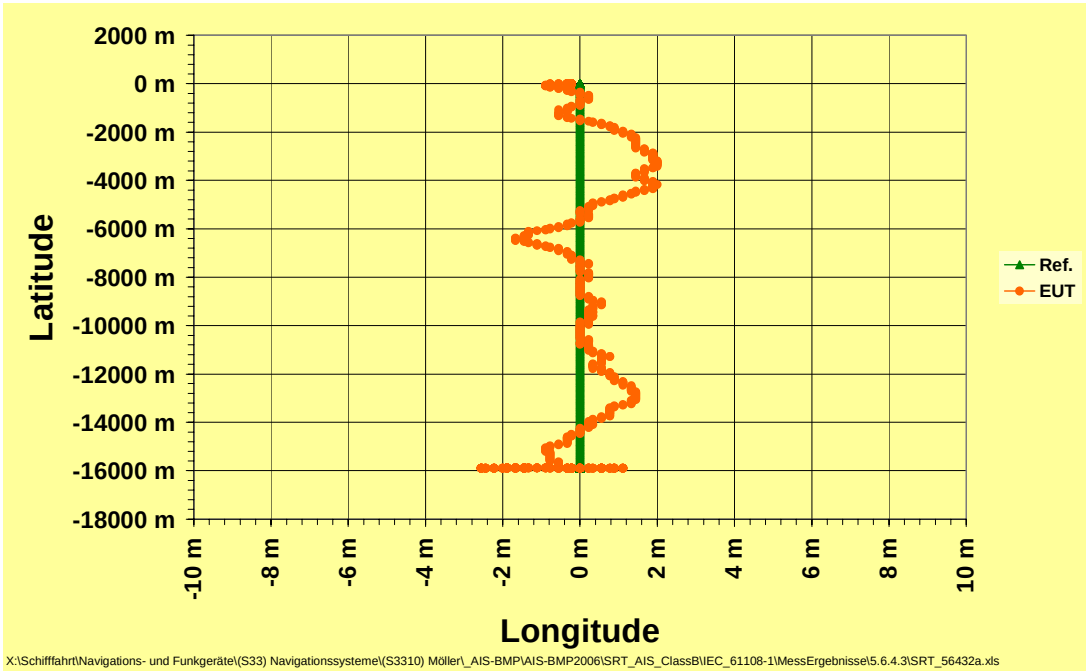
Latitude, coming to rest position



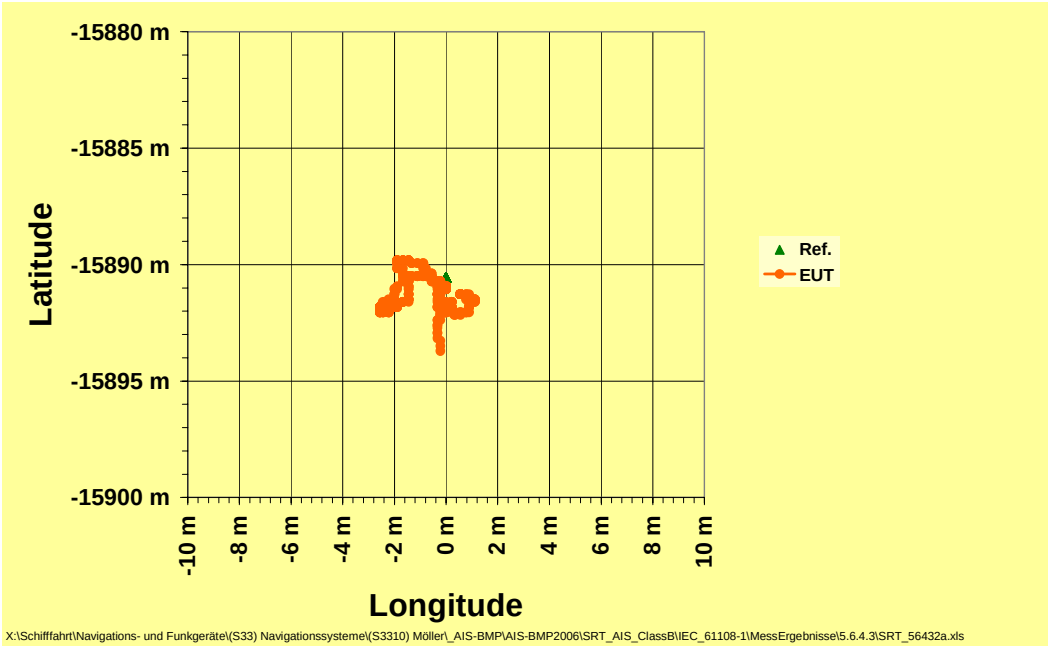
Longitude vs. time



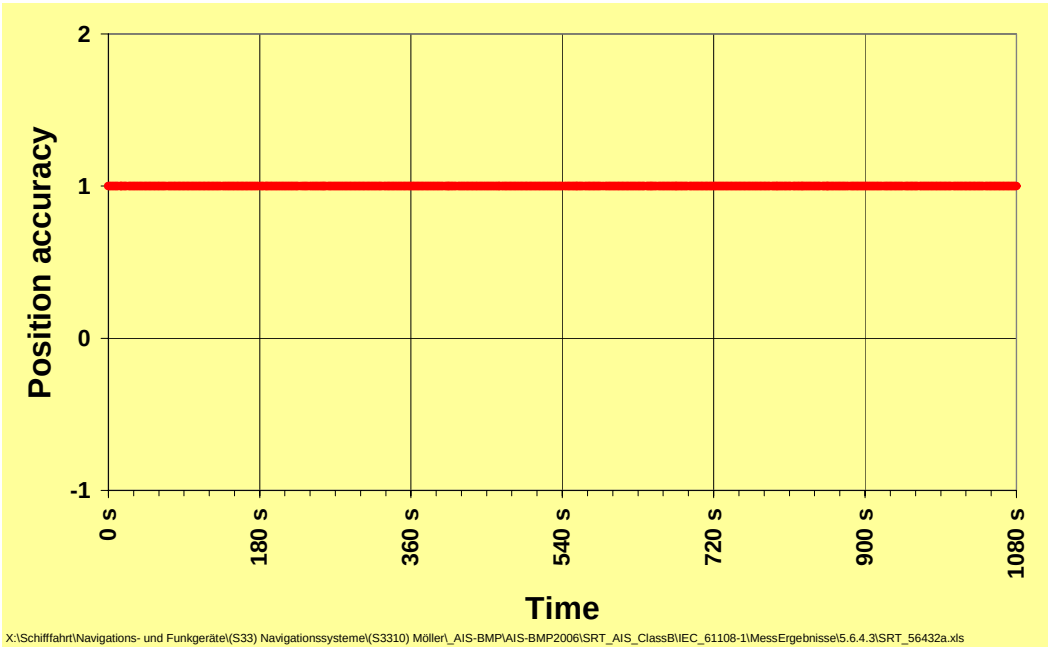
Position



Position, coming to rest position



Position accuracy



B.3.4 §5.6.4.3.2 Differential 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 by using a simulator

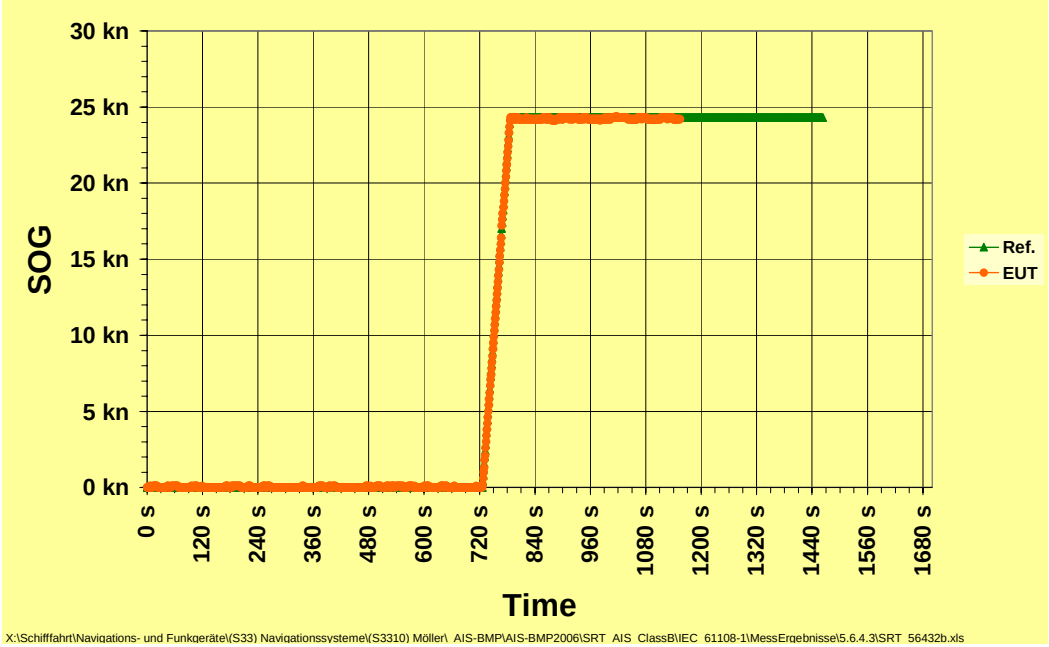
Test results

All positions offsets are within a lane of 30 m.

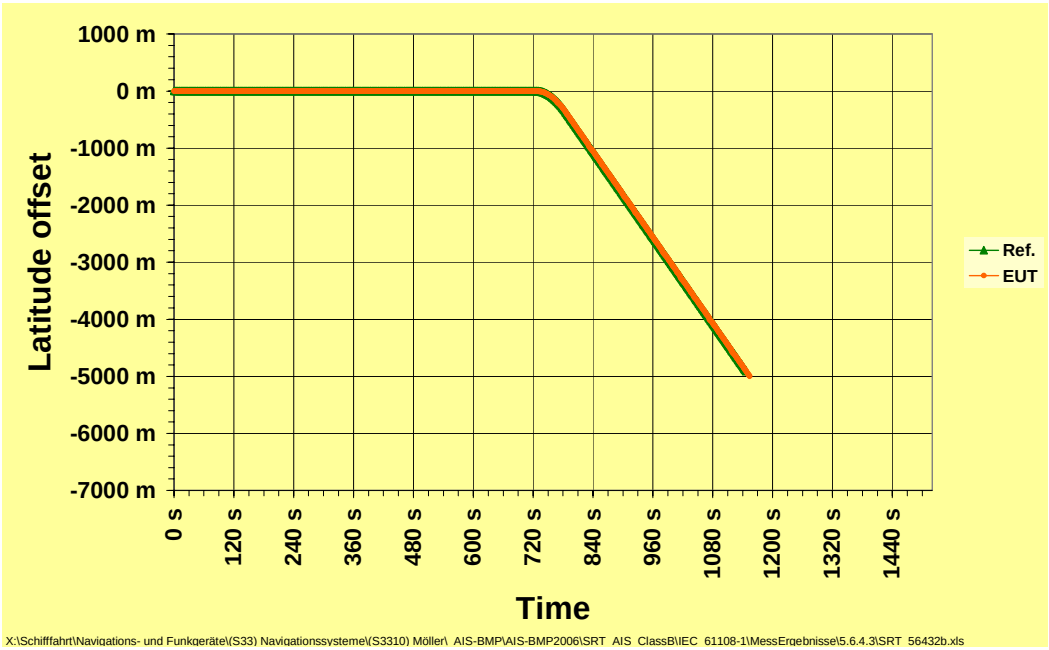
Test result: Passed

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

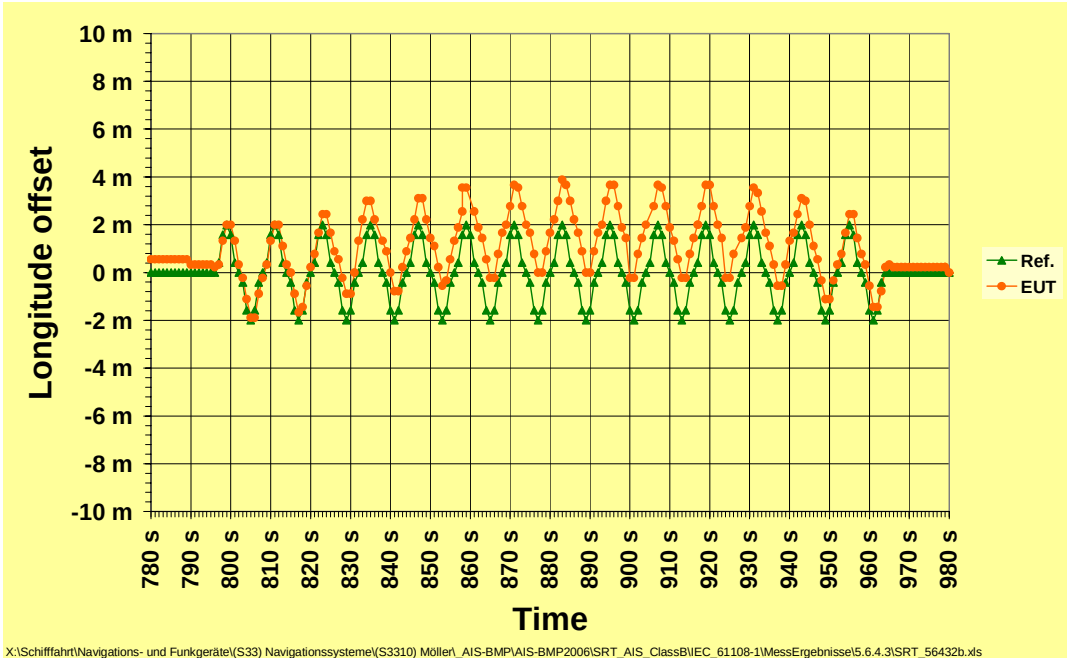
Speed over ground (SOG) vs. time



Latitude vs. time



Longitude vs. time



Position