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**I N T E R S T A T E
S T A N D A R D**

**GOST
33471-2015**

Global navigation satellite system

**ROAD ACCIDENT EMERGENCY RESPONSE
SYSTEM**

**Test methods for navigation module of in-vehicle emergency
call device/system**

**Official Edition
English Version Approved by Interstandard**



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Foreword

The purposes, main principles and basic order of work on interstate standardization are established by GOST 1.0-2015 "Interstate system for standardization. Basic principles" and GOST 1.2-2015 "Interstate System for Standardization. Interstate standards. Rules for development, taking over, renovation and cancellation"

Details

1 DEVELOPED by Non-Commercial Partnership "For Promotion of Navigation Technologies Development and Application" and Joint Stock Company "Research and Technical Centre of Advanced Navigation Technologies" "Internavigation" (JSC "Internavigation RTC")

2 INTRODUCED by Federal Agency on Technical Regulating and Metrology

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Votes in favour:

Short name of the country according to IC (ISO 3166) 004—97	Country code according to IC (ISO 3166) 004—97	Abbreviated name of national standards body
Armenia	AM	Ministry of Economics of Republic of Armenia
Belarus	BY	Gosstandart of Republic of Belarus
Kazakhstan	KZ	Gosstandart of Republic of Kazakhstan
Kyrgyzstan	KG	Kyrgyzstandart
Russian Federation	RU	Rosstandart
Tajikistan	TJ	Tajikstandart

4 Interstate Standard GOST 33471-2015 is introduced as a national standard of the Russian Federation by Order No. 2060-ср, dated 21.12.2016, of Federal Agency on Technical Regulating and Metrology from 01.01.2017.

5 This Standard developed on based GOST R 55534-2013*

6 INTRODUCED FOR THE FIRST TIME

The information on the amendments to this Standard is published in the annually issued information index "National standards", and the text of the amendments and corrections is published in the monthly issued information indices "National standards". In case of revision (replacement) or cancellation of this Standard the appropriate notice will be published in the monthly issued information index "National standards". The appropriate information, notice and texts are also placed in the general-use information system — on official site of Federal Agency on Technical Regulating and Metrology in the Internet (www.gost.ru)

National standard GOST R 55534-2013 is withdrawn from 01.06.2017 by Order No. 2060-ср, dated 21.12.2016, of Federal Agency on Technical Regulating.

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I N T E R S T A T E S T A N D A R D**Global navigation satellite system****ROAD ACCIDENT EMERGENCY RESPONSE SYSTEM****Test methods for navigation module of in-vehicle emergency call device/system**

Date of Introduction — 2017—01—01**1 Scope**

This Standard applies to in-vehicle emergency call devices/systems equipped with a built-in module of the Global Navigation Satellite System and intended for installation on wheeled vehicles of Categories M and N in accordance with the requirements of [1].

The Standard sets out the test methods of in-vehicle emergency call devices/systems for the conformity to the requirements of the Technical Regulation [1] and of GOST 33464 in part of navigation performance and properties stipulated for each module.

The Standard may also be used for conformity assessment of navigation performance and properties of satellite navigation equipment as to the requirements specified in [1].

2 Normative references

The following standards are referred to in this Standard:

GOST 12.1.030-81 Occupational safety standards system. Electric safety. Protective conductive earth, neutralling

GOST 12.3.019-80 Occupational safety standards system. Electrical tests and measurements. General safety requirements

GOST 18321-73 Statistical quality control. Item random sampling methods

GOST 33464-2015 Global navigation satellite system. Road accident emergency response system. In-vehicle emergency call device/system. General technical requirements

GOST 33465-2015 Global navigation satellite system. Road accident emergency response system. Data exchange protocol between In-Vehicle Emergency Call Device/System and Emergency Response System Infrastructure

Note — When using this standard it is expedient to check the validation of the reference standards in the general-use information system — on official site of Federal Agency on Technical regulating and Metrology in Internet or according to the annual information index "National standards" which is published as of January, 1st, of current year, and according to releases of monthly issued information index "National standards" in the current year. If a reference standard which the dated reference is provided to is replaced, it is recommended to use a version of this standard with the above specified year of approval (acceptance). If after the approval of this standard an amendment is inserted in a reference standard which the dated reference is provided to, and this amendment regards the provision referred to, it is recommended to apply this provision without regard to this amendment. If a reference standard is cancelled without a replacement, it is recommended to apply the provision which refers to it to a part which does not engage this reference.

3 Terms, definitions and abbreviations

3.1 Terms and definitions

The following terms with their respective definitions are used for the purposes of this Standard:

3.1.1 **satellite navigation equipment:** Hardware and software facility installed on a vehicle in order to determine current location, movement direction and velocity of that vehicle basing on the signals of at least two active Global Navigation Satellite Systems as well as on the information obtained from additional on-board equipment and from wireless mobile communication networks.

3.1.2 **GNSS navigation module (navigation receiver):** Component part of an in-vehicle emergency call device/system used for evaluation of current vehicle coordinates and movement parameters (direction and velocity) and of time values based on the signals from GLONASS, GPS and other GNSS systems.

Note — Navigation modules included in the IVDS may be either built-in into the IVDS, or external with respect to it (embedded in an electronic unit of other in-vehicle system or device installed on the vehicle).

3.1.3 **in-vehicle emergency call system; IVS:** System supporting the functions of an in-vehicle emergency call device and providing for automatic transmission of vehicle data messages when a road accident or an accident of other kind occurs.

Notes

1 In addition, an in-vehicle emergency call system may be used for manual transmission of vehicle data messages in the case of road accidents or accidents of other type.

2 Categories of vehicles that shall be equipped with in-vehicle emergency call systems are specified in [1].

3.1.4 **Road Accident Emergency Response System:** Automated geographically distributed Federal and State Information System that uses the signals of the GLONASS Global Navigation Satellite System and of other active GNSS to provide for prompt collection of data related to road accidents or other emergencies on motor roads as well as for processing, storage and transmission of such data to emergency services, and to enable access to the said data for the concerned governmental or local authorities, officials, legal and natural persons.

Note — The Road Accident Emergency Response System is called "ERA-RB" in the Republic of Belarus, "EVAK" in the Republic of Kazakhstan, and "ERA-GLONASS" in the Russian Federation. These systems are analogous to the European eCall System currently in development, and are harmonised with it in regard to the main functional features (the use of in-band modem as the main data transmission tool, unified content and format of mandatory data transmitted in the MSD for road accidents, uniform procedures for initiation and termination of duplex voice connection with the persons in the vehicle cabin, etc.).

3.1.5 **cold start mode:** State of GNSS navigation module where the system time, location coordinates, GNSS almanac, and ephemerides of navigation spacecrafts are not known.

Note — The above pertains to location coordinates of the phase centre of a GNSS antenna connected to the navigation module.

3.1.6 **test mode:** IVDS operation mode intended for inspection of IVDS functional properties and parameters when the system/device is in service on the vehicle, or when the tests of various kinds are being performed for the IVDS.

3.1.7 **in-vehicle emergency call device; IVD:** Device used for measurement and evaluation of vehicle coordinates, speed and direction of movement based on the signals from at least two active Global Navigation Satellite Systems, for manual transmission of vehicle data messages when a road accident or an accident of other kind occurs, and for duplex voice communication with emergency services over wireless mobile communication networks.

Notes

1 In addition, an in-vehicle emergency call device may be used for automatic transmission of vehicle data messages in the case of road accidents or accidents of other type. The types of road accidents detected automatically and the time frames for implementation of the function for automatic transmission of vehicle data messages in the device are established in [1].

2 Categories of vehicles that shall be equipped with in-vehicle emergency call devices are specified in [1].

3.2 Abbreviations

The following abbreviations are used for the purposes of this Standard:

C/A	— Pseudo-random code used in GPS GNSS navigation signals accessible for a wide range of civil consumers;
CS	— Coordinate System;
DTM	— NMEA-0183 Protocol sentence containing data on the coordinate system in use;
GGA	— NMEA-0183 Protocol sentence containing time, location and navigation fix quality data;
GLONASS	— Global Navigation Satellite System of the Russian Federation;;
GNSS	— Global Navigation Satellite System;
GPS	— Global Navigation Satellite System used in the United States of America;
GSA	— NMEA-0183 Protocol sentence containing satellites data in the navigation fix;
GSM	— Global System for Mobile communications (global digital standard for cellular mobile communications);
GSV	— NMEA-0183 Protocol sentence containing data on the satellites in view;
IVDS	— In-Vehicle Emergency Call Device/System;
NCE	— Navigation Consumer Equipment;
NS	— Navigation Signals;
NSC	— Navigation Spacecraft;
OD	— Operating Documents;
OM	— Operation Manual;
PC	— Personal Computer;
PDOP	— Position Dilution of Precision (geometric precision of the GNSS consumer's special location);
PIRTR	— NMEA-0183 Protocol query for change of location and time output parameters;
PZ-90	— State Geocentric Coordinate System "Earth parameters as of the year 1990";
RAM	— Random Access Memory;
RMC	— NMEA-0183 Protocol sentence containing the recommended minimum set of navigation data;
RMS	— Root-Mean-Square deviation;
RS	— Recommended Standard;
SIM	— Subscriber Identity Module (SIM-card);
SP	— Standard-Precision navigation signals in GLONASS that are accessible for a wide range of civil consumers;
SPSW	— Special-Purpose Software;
SS	— Simulation Script;
USB	— Universal Serial Bus;
VH	— Vehicle;
VNA	— Vector Network Analyser;
VTG	— NMEA-0183 Protocol sentence containing the ground track and speed data;
WGS-84	— World Geodetic (coordinate) System.

4 General

4.1 The item under test shall be an IVDS with a navigation module (a GNSS navigation receiver) and a GNSS antenna which govern the navigation performance and properties of the system under test.

4.1.1 The total number of IVDS test samples shall be at least three.

4.1.2 Each IVDS shall be submitted to tests in part of the delivery set defined in GOST 33464 (section 5) and accompanied with the OM and the relevant software (on electronic media).

Note — Subject to agreement with the testing laboratory, test items may be submitted with a special external process RF connector. The GNSS antenna should be disconnected in this case.

4.1.3 The documents accompanying each IVDS shall specify:

- device serial number;
- hardware version of platform;
- software version;
- device vendor identifier.

Note — The original copy of the OM containing the above data shall be presented for the tests.

4.1.4 The navigation module (GNSS navigation receiver) shall use the NMEA-0183 Protocol format (shall support RMC, GGA, VTG, GSA, DTM and GSV sentences) [2] to output its measured navigation data to external devices. The IVDS setup procedure for outputting the said data to external devices shall be described in the OM.

4.1.5 The samples submitted to tests shall be selected by an authorised representative of the testing laboratory (certification body) from a batch of finished products that has been accepted by the QC of the manufacturer. Sampling results shall be recorded in the Act of the form corresponding to Appendix A.

4.2 Purpose of tests

The tests are intended to assess the conformity of IVDS navigation performance and properties governed by the navigation module included in it to the requirements of GOST 33464 (subsection 8.1).

4.3 Test conditions

4.3.1 Each IVDS shall be tested in Test mode.

4.3.2 The tests shall be carried out in normal climatic conditions characterised by the following values of climatic factors:

- air temperature: (25 ± 10) °C;
- relative humidity: from 45 to 80 %;
- atmospheric pressure: from 84.0 to 106.7 kPa (from 630 to 800 mm Hg).

Note — During the tests, the sample may be exposed to temperatures within the range of operating temperatures indicated in the OD.

4.3.3 The IVDS under test shall be powered from an on-board vehicle network simulator. The IVDS "on/off" test procedure described in the respective clauses of section 5 for test methods corresponds to the vehicle ignition "on/off" procedure, and shall involve using the toggle or other type of switch powering up (powering down) the on-board network simulator.

4.3.4 No maintenance operations shall be carried out for the samples during the tests.

4.3.5 The test conditions are stated in the respective clauses of section 5 dealing with the test methods.

4.3.6 The testing equipment, auxiliary equipment and measuring instruments used for IVDS tests pertaining to GNCC navigation modules are listed in Table B.1 (Appendix B). Other analogous tools may be used instead of those specified in Table B.1 provided that they are capable of ensuring the required accuracy when the properties of the satellite navigation equipment are measured.

4.4 The occupational safety requirements for the tests are as follows:

- when the IVDS parameters are measured during the tests, the requirements of GOST 12.1.030 and GOST R 12.3.019 as well as the safety requirements presented in the operating documentation for the measuring and testing equipment used in the tests shall be observed;
- measuring instruments and testing equipment used in tests may be turned on only after their external grounding is connected;
- connection and disconnection of cables, devices and measuring instruments is only permitted when the power for all devices included in the testing apparatus is turned off, and the item under test is disconnected from all power circuits.

The requirements of GOST R 12.3.019 as well as the safety requirements of the OD for the IVDS, measuring and testing equipment shall be observed during the tests.

4.5 Scope of tests (checks)

The scope and recommended order of tests (checks) are specified in Table 1. Each sample submitted to tests is subject to all test types listed in Table 1.

Note — The order of checks may be changed provided that the conditions and the schedule described in the respective section for test techniques remains the same.

Table 1 — Scope and recommended order of tests

Types of tests (checks)	Requirement as per GOST 33464	Subsection number
1 Checking that navigation signals of standard precision in L1 band of GLONASS GNSS may be received and processed in order to determine vehicle coordinates and velocity components	8.1.2, 8.1.5	5.1
2 Checking that navigation signals of standard precision in L1 band of GPS GNSS may be received and processed in order to determine vehicle coordinates and velocity components	8.1.3, 8.1.4	5.2
3 Checking that navigation signals of standard precision in L1 band of GLONASS and GPS GNSS may be received and processed in order to determine vehicle coordinates and velocity components	3.1.1	5.3
4 Checking that navigation parameters data may be output to external devices in NMEA-0183 format	8.1.15	5.4
5 Checking receiver autonomous integrity monitoring (RAIM) algorithm	8.1.4	5.5
6 Checking that navigation parameters may be determined in PZ-90 and WGS-84 coordinate systems	8.1.6	5.6
7 Estimating error in evaluation of plane view coordinates and altitude in autonomous static mode	8.1.7	5.7
8 Estimating error in evaluation of plane view coordinates, altitude and velocity in dynamic mode	8.1.7	5.8
9 Checking minimum time interval of observation data updates	8.1.8	5.9
10 Checking time to restore tracking signals of working NSC constellation after tracking fault caused by blockage	8.1.9	5.10
11 Evaluating time of navigation fix in cold start mode	8.1.10	5.11
12 Evaluating sensitivity of GNSS navigation module in: - GNSS signal search mode (locking); - GNSS signal hold mode (tracking)	8.1.11	5.12
13 Checking that data output rate may be changed in required range using GNSS_DATA_RATE setup parameter	8.1.12, 8.1.13	5.13
14 Checking minimum elevation (cut-off angle) for navigation spacecrafts	8.1.14	5.14
15 Checking power-off time of navigation module (GNSS navigation receiver) after ignition is turned off	8.1.16	5.15

4.6 If special software is used to calculate the errors in evaluation of location coordinates and velocity by the navigation module during the tests, then the programs used for such calculations shall be based on the formulas specified in section 5.

4.7 Testing equipment used shall be certified and provided with a certificate of approval valid for the period of tests.

4.8 All testing devices shall be operational, and shall be accompanied with a type approval certificate (for measuring instruments).

4.9 Measuring instruments be calibrated (and have either calibration certificates, or calibration marks applied to the device or stamped in the OD; the calibration period shall not expire during the period of tests).

4.10 Reporting test results

A test and measurement report shall be compiled based on the results of the tests (checks). The report shall include the following information:

- designation, location, telephone, fax and e-mail of the testing laboratory (centre);
- identification of the item under test;
- test conditions;
- description of the test and measurement techniques with a reference to this Standard;
- list of the testing equipment and measuring instruments used in tests;
- measurements results in regard to navigation performance and properties of the GNSS navigation module included in the IVDS;
- list of sections (clauses and sub-clauses) of normative documents (GOST, etc.) that contain the requirements the conformity was checked against, and conformity assessment results pertaining to each particular requirement;
- conclusion on conformity of the item under test to the requirements specified;
- title, name and signature of the employee who completed the tests and measurements;
- title, name and signature of the director of the testing laboratory (centre), affixed with the seal of that laboratory (centre);
- date of tests and measurements; report issue date and registration number.

5 Test methods

5.1 Checking that navigation signals of standard precision in L1 band of GLONASS GNSS may be received and processed in order to determine vehicle coordinates and velocity components

5.1.1 Assemble the circuit shown in Figure C.1 (Appendix C).

5.1.2 Turn on the IVDS and prepare it for operation as described in the OM.

Note — Hereinafter the wording "turn on the IVDS" refers to the procedure specified in 4.3.3.

5.1.3 Prepare the simulator for operation as described in its OM. Start the script that simulates GLONASS signals only and uses the motion path parameters listed in Table D.2 (Appendix D).

5.1.4 The test shall be considered successful if the location coordinates and velocity components have been determined, and have been proved suitable for viewing on the PC.

5.2 Checking that navigation signals of standard precision in L1 band of GPS GNSS may be received and processed in order to determine vehicle coordinates and velocity components

5.2.1 Assemble the circuit shown in Figure C.1 (Appendix C).

5.2.2 Turn on the IVDS and prepare it for operation as described in the OM.

5.2.3 Prepare the simulator for operation as described in the OM. Start the SS using GPS signals only with the motion path parameters listed in Table D.2 (Appendix D).

5.2.4 The test shall be considered successful if the location coordinates and velocity components have been determined, and have been proved suitable for viewing on the PC.

5.3 Checking that navigation signals of standard precision in L1 band of GLONASS and GPS GNSS may be received and processed in order to determine vehicle coordinates and velocity components

- 5.3.1 Assemble the circuit shown in Figure C.1 (Appendix C).
- 5.3.2 Turn on the IVDS and prepare it for operation as described in the OM.
- 5.3.3 Prepare the simulator for operation as described in the OM. Start the SS using GLONASS and GPS signals with the motion path parameters listed in Table D.2 (Appendix D).
- 5.3.4 The test shall be considered successful if the location coordinates and velocity components have been determined, and have been proved suitable for viewing on the PC.

5.4 Checking that navigation parameters data may be output to external devices in NMEA-0183 format

- 5.4.1 Assemble the circuit shown in Figure C.1 (Appendix C).
- 5.4.2 Turn on the IVDS and prepare it for operation as described in the OM. Use the OM and the developer's software to configure the navigation module for output of NMEA-0183 sentences (RMC, GGA, VTG, GSA and GSV as per [2]).
- 5.4.3 Prepare the simulator for operation as described in the OM. Start the script that simulates GLONASS/GPS signals, and uses the motion path parameters listed in Table D.1 (Appendix D).
- 5.4.4 Connect the IVDS to the PC using an appropriate interface. Analyse the capability of receiving navigation data using NMEA-0183 Protocol [2].
- 5.4.5 The test results shall be considered satisfactory if the navigation data may be received using NMEA-0183 Protocol [2].

5.5 Checking receiver autonomous integrity monitoring (RAIM) algorithm

- 5.5.1 Assemble the circuit shown in Figure C.1 (Appendix C).
- 5.5.2 Using the GLONASS/GPS simulator software, create a simulation script with the parameters listed in Table D.1 (Appendix D) such that the simulated errors in ephemeris and timing data for any of the three GLONASS/GPS navigation spacecrafts would occur 10 min after the script is started.
- 5.5.3 Run the simulation script created above.
- 5.5.4 After 10 min of script execution, use the specific GNSS navigation module software to check that no NSC signals are received while the ephemeris and timing errors are simulated.
- 5.5.5 The test results shall be considered satisfactory if the requirement of 5.5.4 is satisfied.

5.6 Checking that navigation parameters may be determined in PZ-90 and WGS-84 coordinate systems

- 5.6.1 Assemble the circuit shown in Figure C.1 (Appendix C).
- 5.6.2 Prepare the IVDS for operation as described in the OM. Turn on the IVDS, then use the OM and the developer's software to configure the navigation module for reception of GLONASS and GPS signals and for output of navigation parameters in the PZ-90 coordinate system.

Note — The use of the PIRTR sentence is permitted for setting the operating coordinate system [2].

- 5.6.3 Prepare the simulator for operation as described in its OM. Start the SS for GLONASS signals only, with the motion path parameters as indicated in Table D.1 (Appendix D).
- 5.6.4 Check that the navigation parameters have been properly calculated using GLONASS signals, and are displayed in PZ-90 coordinate system (DTM sentence as per [2]).
- 5.6.5 Configure the navigation module for output of NMEA-0183 Protocol sentences (GGA, RMC, VTG, GSA and GSV as per [2]) at a rate of 1 Hz.
- 5.6.6 Record the messages delivered by the navigation module until the selected SS is stopped.
- 5.6.7 Repeat the test procedures of 5.6.1—5.6.5 with the SS for GPS signals only, using the motion path parameters indicated in Table D.1 (Appendix D) and WGS-84 as an operating coordinate system.
- 5.6.8 From each data array recorded as per 5.6.6, select 50 GGA (RMC) sentences corresponding to the same time moments.

5.6.9 Following GOST 32453, convert the values obtained in the coordinate system used to take these measurements, to another system.

5.6.10 Compare the coordinates obtained in the test with their converted values making provisions for the following permitted tolerances for evaluation of coordinates with a confidence probability of 0.95:

- plane view coordinates: 15 m;
- altitude: 20 m.

5.6.11 The test results shall be considered satisfactory if the coordinate array obtained in the tests matches the calculated one.

Note — The check if the navigation parameters can be determined in the PZ-90 coordinate system is optional until January 1, 2018.

5.7 Estimating error in evaluation of plane view coordinates and altitude in autonomous static mode

5.7.1 Assemble the circuit shown in Figure C.1 (Appendix C).

5.7.2 Prepare the IVDS for operation as described in the OM. Turn on the IVDS, and use the developer's software to check that the navigation module is configured for reception of GLONASS as well as GPS signals, and the GNSS_MIN_ELEVATION setup parameter is set to 5 degrees. Configure the navigation module for output of NMEA-0183 Protocol sentences (GGA, RMC, VTG, GSA and GSV as per [2]) at a rate of 1 Hz.

Note — The output rate of navigation messages delivered by the navigation module of the IVDS is set using the GNSS_DATA_RATE setup parameter.

5.7.3 Prepare the simulator for operation as described in its OM. Start the SS for GLONASS signals only, using the simulation parameters indicated in Table D.1 (Appendix D).

5.7.4 Once a navigation fix is received after the SS is started, ensure that the messages from the GNSS navigation module are recorded in a file until the selected SS is stopped.

5.7.5 Extract GGA (RMC) data from the above file that pertain to location coordinates obtained in the tests: latitude (B), longitude (L) and altitude (H).

5.7.6 Calculate the systematic error in evaluation of coordinates over the stationary intervals for latitude (B) using the following formulas:

$$\Delta B(j) = |B(j) - B_{\text{ист}j}|, \quad (1)$$

$$dB = \frac{1}{N} \sum_{j=1}^N \Delta B(j), \quad (2)$$

where $B_{\text{ист}j}$ is the actual value of B coordinate at j -th time moment, in arc s;

B_j is the B coordinate value evaluated by the navigation module at j -th time moment, in arc s;

N is the number of GGA (RMC) sentences received from the navigation module in the tests.

Using a similar technique, calculate the systematic errors for L and H coordinates.

Note — Here and in clause 5.8 below, the error assessment in evaluation of the altitude is optional.

5.7.7 Use the following formulas to convert the calculated errors in evaluation of the latitude and longitude from seconds of arc to metres:

- for latitude:

$$dB_M = 2 \frac{a(1-e^2)}{(1-e^2 \sin^2 \varphi)^{3/2}} \frac{0,5'' \pi}{180 \cdot 3600''} dB, \quad (3)$$

- dB for longitude:

$$dL_M = 2 \frac{a \cos \varphi}{\sqrt{1-e^2 \sin^2 \varphi}} \frac{0,5'' \pi}{180 \cdot 3600''} dL, \quad (4)$$

where a is the major axis of the ellipsoid, m;

- e is the first eccentricity;
 φ is the current latitude, radians;
 dB_M is the systematic error in evaluation of coordinates for latitude, m;
 dL_M is the systematic error in evaluation of coordinates for longitude, m;
 dB is the systematic error in evaluation of coordinates for latitude, arc s;
 dL is the systematic error in evaluation of coordinates for longitude, arc s.
 5.7.8 Calculate the r.m.s. deviation of the evaluated coordinates in metres for coordinate B :

$$\sigma_{B_M} = \sqrt{\frac{\sum_{j=1}^N (\Delta B(j)_M - dB_M)^2}{N-1}}. \quad (5)$$

Note — The value of $\Delta B(j)_M$ is calculated using Eq. (3) based on the calculated values of $\Delta B(j)$.

In the same manner, calculate the r.m.s. for the evaluated coordinates L and H .

5.7.9 Use the following formulas to calculate the error in evaluation of plane view coordinates and of altitude, correspondingly (with a confidence probability of 0.95):

$$\Pi_{\text{план}} = \sqrt{dB_M^2 + dL_M^2} + 2\sqrt{\sigma_{B_M}^2 + \sigma_{L_M}^2}, \quad (6)$$

$$\Pi_{H_M} = dH_M + 2\sigma_{H_M}. \quad (7)$$

5.7.10 Repeat the test procedures 5.7.3—5.7.9 using the SS for GPS signals only and the simulation parameters indicated in Table D.1 (Appendix D).

5.7.11 Repeat the test procedures 5.7.3—5.7.9 using the SS for the signals of the combined GLONASS/GPS constellation and selecting the simulation parameters as shown in Table D.1 (Appendix D).

5.7.12 Repeat the test procedures 5.7.2—5.7.11 for other IVDS samples submitted for tests.

5.7.13 Calculate the average values [Eqs. (6) and (7)] for the total number of IVDS samples tested.

5.7.14 Connect the GNSS antenna included in the IVDS to the sample under test. Repeat the test procedures 5.7.4—5.7.13 in real time so that the navigation signals are transmitted from the antenna located at a geodetic point (check point) in response to real signals of GLONASS/GPS.

5.7.15 The test results shall be deemed satisfactory if the average coordinate and altitude errors obtained during the tests in accordance with 5.7.13 do not exceed (with a confidence probability of 0.95) the following permitted values:

- 15 m — for plane view coordinates;
- 20 m — for altitude.

5.8 Estimating error in evaluation of plane view coordinates, altitude and velocity in dynamic mode

5.8.1 Assemble the circuit shown in Figure C.1 (Appendix C).

5.8.2 Prepare the IVDS for operation as described in the OM. Turn on the IVDS, and use the developer's software to make sure that the navigation module is configured for reception of GLONASS and GPS signals, and that the GNSS_MIN_ELEVATION setup parameter is set to 5°. Configure the navigation module for output of NMEA-0183 Protocol sentences (GGA, RMC, VTG, GSA and GSV as per [2]) at a rate of 1 Hz.

Note — The output rate of navigation messages delivered by the navigation module of the IVDS is set using the GNSS_DATA_RATE setup parameter.

5.8.3 Prepare the simulator for operation as described in its OM. Start the SS for speed-up to the maximum velocity which is specified in the OM for the IVDS under test while simulating GLONASS signals only (Table D.2, Appendix D).

5.8.4 Once a navigation fix is received after the SS is started, ensure that the messages output by the GNSS navigation module are recorded in a file until the selected SS is stopped.

5.8.5 Extract those message data from the above file that pertain to coordinates evaluated by the navigation module (latitude, longitude, altitude) and to velocity, at the stage of steady motion with the maximum velocity (not taking into account the accelerating moment).

5.8.6 Using Eq. (1)—(7), calculate the error in evaluation of plane view coordinates and of altitude (with a confidence probability of 0.95).

5.8.7 Using Eq. (8)—(10), calculate the systematic error and the r.m.s. deviation of the resulting velocity:

$$\Delta V(j) = |V(j) - V_{\text{нст}j}|, \quad (8)$$

$$dV = \frac{1}{N} \sum_{j=1}^N \Delta V(j), \quad (9)$$

$$\sigma V = \sqrt{\frac{\sum_{j=1}^N (\Delta V(j) - dV)^2}{N - 1}}, \quad (10)$$

where $V_{\text{нст}j}$ is the actual velocity at j -th time moment, m/s;
 V_j is the measured velocity at j -th time moment, m/s;
 N is the number of RMC (VTG) sentences received from the navigation module during the tests.

5.8.8 Using the formula below, calculate the error in evaluation of velocity (with a confidence probability of 0.95):

$$\Pi_V = dV + 2\sigma V. \quad (11)$$

5.8.9 Set the mode where GPS signals only are simulated by the SS for speed-up to the maximum velocity, and carry out the procedures 5.8.4—5.8.8.

5.8.10 Set the mode where signals of the combined GLONASS and GPS constellation are simulated by the SS for speed-up to the maximum velocity, and carry out the procedures 5.8.4—5.8.8.

5.8.11 Repeat the test procedures 5.8.2—5.8.10 for remaining IVDS samples submitted for tests.

5.8.12 Determine the average values for the quantities obtained from Eq. (6), (7) and (11) using the SS for speed-up to the maximum velocity (Table D.2 (Appendix D)), with respect to the total number of the IVDS samples under test.

5.8.13 Repeat the test procedures 5.8.2—5.8.12 for movement simulation scripts with manoeuvring (Table D.3 (Appendix D)) and for movement in blockage zones as well as in poor-reception zones of navigation signals (Table D.4 (Appendix D)).

5.8.14 Take averages of the quantities obtained from Eq. (6), (7) and (11) for dynamic mode with respect to the total number of simulation scripts executed for such mode.

5.8.15 The IVDS test results in dynamic mode shall be deemed satisfactory if the errors obtained in the resulting plane view coordinates, altitude and movement velocity do not exceed (with a confidence probability of 0.95) the following permitted values:

- 15 m — for plane view coordinates;
- 20 m — for altitude;
- 0.1 m/s — for velocity.

5.9 Checking minimum time interval of observation data updates

5.9.1 Analyse the file containing the results of tests as per 5.8. Confirm that no identical coordinate values exist for adjacent (with respect to a timestamp) GGA sentences.

5.9.2 The test result shall be considered satisfactory if the requirement 5.9.1 holds.

5.10 Checking time to restore tracking signals of working NSC constellation after tracking fault caused by blockage

- 5.10.1 Assemble the circuit shown in Figure C.1 (Appendix C).
 - 5.10.2 Prepare the IVDS for operation as described in the OM. Turn on the IVDS. Using the developer's software, make sure that the GNSS module is configured for reception of GLONASS and GPS signals.
 - 5.10.3 Prepare the simulator for operation as described in its OM. Start the script simulating GLONASS/GPS signals with the parameters specified in Table D.1 (Appendix D).
 - 5.10.4 Connect the GNSS antenna cable to the IVDS.
 - 5.10.5 Wait for a navigation fix to be received by the navigation module of the IVDS.
 - 5.10.6 Disconnect the antenna cable from the IVDS (i.e. from its navigation module) and reconnect it again after 20 to 60 s.
- Using a stopwatch, measure the time interval between the moment when the antenna is disconnected and reconnected and the moment when an indication that the tracking from the working NSC constellation has resumed appears in the interface program dialog (once the first navigation fix is received after the connection of the antenna).
- 5.10.7 Repeat the test procedure 5.10.6 at least 10 times.
 - 5.10.8 Based on the sampled measurement results, calculate the average time required to restore the tracking signals from the working NSC constellation after the IVDS leaves the blockage zone, for all IVDS samples submitted to tests.
 - 5.10.9 The test result shall be considered satisfactory if the average time to restore the tracking of signals from the working NSC constellation after such tracking is stopped due to blockage does not exceed 5 s after the NSC visibility is recovered.
 - 5.10.10 Repeat the test procedures 5.10.3—5.10.9 using the SS for GLONASS signals only and the simulation parameters indicated in Table D.1 (Appendix D).
 - 5.10.11 Repeat the test procedures 5.10.3—5.10.9 using the SS for GPS signals only and the simulation parameters indicated in Table D.1 (Appendix D).

5.11 Evaluating time of navigation fix in cold start mode

- 5.11.1 Assemble the circuit shown in Figure C.1 (Appendix C).
- 5.11.2 Prepare the IVDS for operation as described in the OM. Turn on the IVDS. Using the developer's software, make sure that the GNSS module is configured for reception of GLONASS and GPS signals.
- 5.11.3 Prepare the simulator for operation as described in its OM. Start the script simulating GLONASS/GPS signals with the parameters specified in Table D.1 (Appendix D).
- 5.11.4 Clear the navigation module RAM from all NSC ephemerides and constellation almanacs.
- 5.11.5 Connect the GNSS antenna cable to the IVDS. Using a stopwatch, measure the time interval from the moment when the antenna is connected to the moment when the interface program dialog with the navigation fix appears.
- 5.11.6 Repeat the tests as per 5.11.4 and 5.11.5 at least 10 times.
- 5.11.7 Based on the sampled measurement results, calculate the average time required to receive the navigation fix in cold start mode (where no almanac, ephemerides, time and coordinates are known) for all IVDS samples submitted to tests.
- 5.11.8 Repeat the test procedures 5.11.3—5.11.7 using the SS for GLONASS signals only and the simulation parameters indicated in Table D.1 (Appendix D).
- 5.11.9 Repeat the test procedures 5.11.3—5.11.7 using the SS for GPS signals only and the simulation parameters indicated in Table D.1 (Appendix D).
- 5.11.10 The test result shall be considered satisfactory if the average time calculated as described in 5.11.7 does not exceed 60 s.

5.12 Evaluating sensitivity of GNSS navigation module in GNSS signal search (locking) mode and in GNSS signal hold (tracking) mode

- 5.12.1 Turn on the vector network analyser. Calibrate the VNA as described in its OM.
- 5.12.2 Assemble the circuit shown in Figure C.2 (Appendix C).
- 5.12.3 Set zero signal path attenuation on attenuators. Measure the frequency response for a given signal path in the L1 band of GLONASS/GPS. Record the average path transmission factor $K_{\text{пл_тракт}}$, dB, in this frequency band.

5.12.4 Assemble the circuit shown in Figure C.3 (Appendix C).

5.12.5 Prepare the IVDS for operation as described in the OM. Turn on the IVDS. Using the developer's software, make sure that the navigation module is configured for reception of GLONASS and GPS signals. Clear the navigation module RAM from all NSC ephemerides and GNSS almanac so as the cold start conditions of the navigation module are achieved.

5.12.6 Set the signal path attenuation on attenuators equal to 70 dB. Prepare the simulator for operation as described in its OM. Start the script for simulation of GLONASS/GPS signals using the parameters of Table D.1 (Appendix D). Set the output power $P_{\text{СИГН}}$ of the simulator equal to minus 150 dBW.

5.12.7 Check that the date, time and coordinates are reset in the interface program dialog.

5.12.8 Decrease the signal path attenuation setting on attenuators in 1 dB steps (increase the navigation signal power on the navigation module input) until the IVDS acquires a navigation fix. Record the attenuator readings $A_{\text{АТТ}}$ and calculate the sensitivity P_{min} of the navigation module using the following formula and taking into account the transmission factor of the signal path.

$$P_{\text{min}} = P_{\text{СИГН}} + K_{\text{П_ТРАКТ}} + A_{\text{АТТ}}. \quad (12)$$

Note — Switch the attenuators at least each 120 s to monitor whether the navigation fix output by the navigation module of the IVDS is available.

5.12.9 Set the signal path attenuation on attenuators such that the signal on the antenna input of the IVDS is equal to minus 160 dBW. Wait for 15 min to let the navigation module collect the ephemerides of the working NSC and the GNSS almanac.

5.12.10 Increase the signal path attenuation setting on attenuators in 1 dB steps (decrease the navigation signal power) until the navigation fix is reset. Taking into account the initial transmission factor of the signal path, record such GNSS signal level on the antenna input of the IVDS that resulted in the last navigation fix of the GNSS module in hold (tracking) mode.

5.12.11 The test results shall be considered satisfactory if the GNSS signal level on the antenna input of the IVDS does not exceed minus 163 dBW in search mode as recorded in 5.12.8 and does not exceed minus 180 dBW in hold (tracking) mode as recorded in 5.12.10, for each IVDS submitted to tests.

5.13 Checking that data output rate may be changed in required range using GNSS_DATA_RATE setup parameter

5.13.1 Assemble the circuit shown in Figure C.4 (Appendix C).

Notes

1. It is recommended to combine these tests with the tests described in 5.8.
2. If the navigation module of the IVDS does not support changing the output rate of navigation data, the tests are carried out in accordance with 5.13.2—5.13.5.
3. If the navigation module of the IVDS supports changing the output rate of navigation data, the tests are carried out in accordance with 5.13.2—5.13.8 after the tests of navigation performance for the combined GLONASS/GPS constellation are completed as per 5.8.

5.13.2 Prepare the IVDS for operation as described in the OM. Turn on the IVDS. Using the developer's software, make sure that the GNSS module is set up for reception of GLONASS and GPS signals. Configure the navigation module for output of NMEA-0183 sentences (GGA, RMC, GGA, VTG, GSA and GSV) as per [2]) at a rate of 1 Hz.

Note — The output rate of navigation messages delivered by the navigation module of the IVDS is set using the GNSS_DATA_RATE setup parameter.

5.13.3 Turn on the oscilloscope and set it up for signal reception in the specified frequency band.

5.13.4 Prepare the simulator for operation as described in its OM. Start the SS for speed-up to the maximum velocity which is specified in the OM for the IVDS under test while simulating GLONASS and GPS signals (Table D.2, Appendix D).

5.13.5 Once a navigation fix is received, use the oscilloscope to check that the output rate of the navigation module data corresponds to the configured value.

5.13.6 Stop the SS, and change the value of the GNSS_DATA_RATE parameter in the navigation module settings, e.g., set it to 2 Hz.

5.13.7 Start the SS and use the oscilloscope or the SPSW of the GNSS simulator to check that the output rate corresponds to the specified value.

5.13.8 Repeat the steps 5.13.6 and 5.13.7 with GNSS_DATA_RATE set to 5 and to 10 Hz.

5.13.9 The test results shall be considered satisfactory if the data output rate settings of 1, 2, 5 and 10 Hz are possible using the GNSS_DATA_RATE parameter, for each IVDS submitted to tests.

Note — If changing the data output rate instrumentally is impossible, this rate should be checked by analysing NMEA-0183 messages with timestamps.

5.14 Checking minimum elevation (cut-off angle) for navigation spacecrafts

5.14.1 Assemble the circuit shown in Figure C.1 (Appendix C).

5.14.2 Prepare the IVDS for operation as described in the OM. Turn on the IVDS. Using the developer's software, make sure that the navigation module is configured for GLONASS and GPS signals.

5.14.3 Using the developer's software, set the GNSS_MIN_ELEVATION parameter (minimum NSC elevation, or cut-off angle) to 5°.

5.14.4 Prepare the simulator for operation as described in its OM. Using the script for simulation of GLONASS/GPS signals (Table D.1, Appendix D), find a navigation satellite from among descending spacecrafts (either GLONASS or GPS) such that the time moment t_1 when an elevation of 5° is reached will be most close to the SS start-up time. Record this time and the satellite identifier it corresponds to.

5.14.5 Start the SS for GLONASS/GPS systems using the parameters listed in Table D.1 (Appendix D).

5.14.6 Observe the selected NSC on the PC screen and check that it is excluded from processing after time moment t_1 (as indicated by a GSA sentence). Stop the script.

5.14.7 Using the developer's software, set GNSS_MIN_ELEVATION (minimum NSC elevation, or cut-off angle) to 15°.

Repeat the steps 5.14.4—5.14.6 taking t_1 for the SS start-up moment.

5.14.8 The test results shall be considered satisfactory if the cut-off angle of all selected NSC corresponds to the configured values (5°, 15°) for all IVDS submitted to tests.

Note — The check 5.14 is optional for systems in standard configuration (GOST 33464, clause 8.1.14).

5.15 Checking power-off time of navigation module (GNSS navigation receiver) after ignition is turned off

5.15.1 Prepare the IVDS for operation as described in the OM. Turn on the IVDS. Switch the developer's software to viewing and editing of IVDS setup parameters.

5.15.2 Check and record the GNSS_POWER_OFF_TIME setting for the IVDS under test. Enter a new value for GNSS_POWER_OFF_TIME equal to 10 s.

Note — This parameter shall have been set to 500 ms initially (see GOST 33464, Appendix A).

5.15.3 Turn off the IVDS, and use a stopwatch to record its actual power-off time as observed by the state of the system status indicator.

5.15.4 Make sure that the recorded power-off time corresponds to a value specified in 5.16.2 for all IVDS samples submitted to tests.

5.15.5 Enter the initial setting for GNSS_POWER_OFF_TIME as described in 5.15.1—5.15.2.

Note — The check 5.15 is optional for systems in standard configuration (GOST 33464, clause 8.1.16).

Appendix B
(mandatory)

List of measuring instruments, testing and auxiliary equipment

Table B.1 — List of measuring instruments, testing and auxiliary equipment

Designation of testing equipment	Technical requirements for testing equipment		Recommended model (type) of testing equipment
	Measuring range	Measurement error	
1 Geodetic point (check point)	Coordinates to be expressed in Systems of Earth geodetic parameters as of 1990 (PZ-90) and WGS-84	Difference of coordinates transmitted from network of geodetic points: at most 0.1 m. Average r.m.s. error in evaluation of coordinates with respect to geodetic points in PZ-90 & WGS-84 coordinate systems: at most 0.1 m	Geodetic point (check point)
2 GNSS antenna	Operating frequency range: (1570-1610) MHz; Gain: 41 dB; Noise factor in L1 GNSS range: at most 3.5 dB	Error in gain measurements: ± 2.5 dB	Antenna assembly from the set NCE GNSS GLONASS/GPS "БРИЗ-МВ" 14Ц814. ТДЦК.461513.004
3 Low-noise amplifier	Frequency range: (950—2150) MHz; Noise factor: at most 2.0 dB; Gain: (24 ± 2) dB	—	ZRL-2150+ low-noise amplifier
4 Power supply	D.C. voltage setting range: from 0.1 to 30 V Output voltage current: at least 3 A	$\Pi\Gamma_0 \pm 3 \%$ $\Pi\Gamma_1 \pm 1 \%$	Power supply ATH-2031
5 Simulator of GLONASS and GPS signals	Number of simulated signals: at least 16	Maximum r.m.s. for random component of basic error in unsolicited generation of NSC distance signals for GLONASS/GPS: - phase of long-distance code: 0.1 m; - carrier phase: 0.001 m; - pseudo-velocity: 0.005 m/s	Simulators of signals transmitted by GLONASS/GPS navigation satellite systems: - CH-3803M; - CH-3805M; - GSS6300
6 Digital stopwatch	Maximum count range: 9 h 59 min 59.99 s	Daily variation at $(25 \pm 5) ^\circ\text{C}$: at most + 1.0 s. Time sampling resolution: 0.01 s.	"ИНТЕГРАЛ С-01"
7 Vector network analyser	Frequency range: 300 kHz — 4 GHz Dynamic range: minus 85...40 dB	$\Pi\Gamma_F 1 \cdot 10^{-6}$ $\Pi\Gamma_A 0.1...0.5$ dB	Rohde & Schwarz ZVB-4 vector network analyser

Table B.1 (continued)

Designation of testing equipment	Technical requirements for testing equipment		Recommended model (type) of testing equipment
	Measuring range	Measurement error	
8 Attenuator	Dynamic range: 0...11 dB	$\Pi\Gamma \pm 0.5$ dB	HP 8494A attenuator
9 Attenuator	Dynamic range: 0...70 dB	$\Pi\Gamma \pm 0.5$ dB	HP 8495A attenuator
10 Signal generator	Frequency range: 1...2 GHz Dynamic range: minus 150 ... minus 5 dBW	$\Pi\Gamma_F \pm 1 \cdot 10^{-6}$ $\Pi\Gamma_A 0.5...0.9$ dB	Rohde & Schwarz SMBV100A, SMB100A vector signal generators
11 Oscilloscope	Bandwidth: at least 2 GHz Sampling rate: at least 40 GHz Dynamic range: from 1 mV to 3 V	$\Pi\Gamma_T \pm 1 \cdot 10^{-6}$ $\Pi\Gamma_A \pm 3$ %	Agilent Technologies DSO80204B oscilloscope

Note — The use of other equipment types is permitted provided that they are capable to ensure the required accuracy of measurements in the specified range.

Appendix C (mandatory)

Connection diagrams used for tests

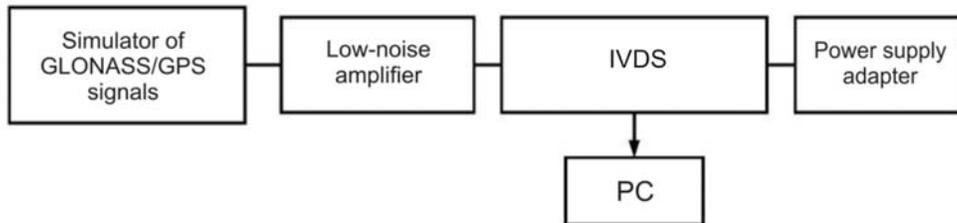


Figure C.1 — Test bench arrangement

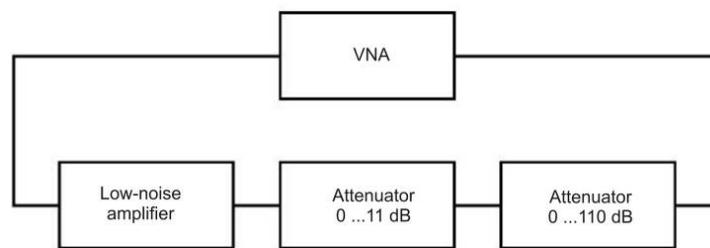


Figure C.2 — Signal path calibration diagram

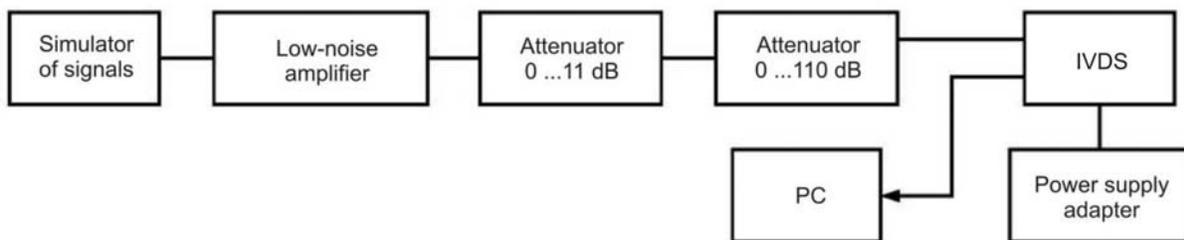


Figure C.3 — Flow-chart of GNSS module sensitivity evaluation

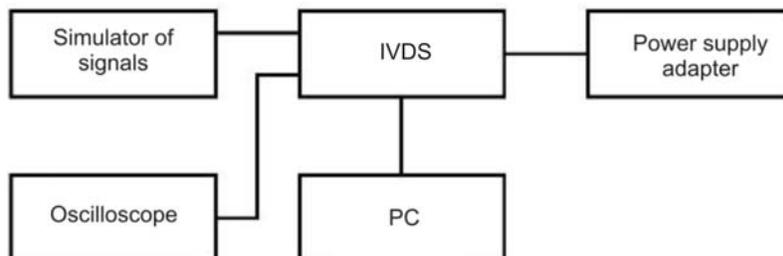


Figure C.4 — Test bench arrangement

Appendix D (mandatory)

Basic parameters of scripts used for simulation of GLONASS and GPS signals

Table D.1 — Basic parameters of script for simulation of fixed spatial location

Simulated parameter	Value
1 SS run time, hh:mm:ss	00:30:00
2 IVDS location in: - CKWGS-84; - PZ-90	Central Russia Central Russia
3 Parameters of NS transmission medium: - troposphere; - ionosphere	Standard "Autumn" model
4 PDOP geometry factor	≤ 4
5 Simulated signals	GNSS GLONASS (L1 frequency range, SP code); GNSS GPS (L1 frequency range, C/A code); GNSS GLONASS/GPS
6 Minimum RF signal power: - GNSS GLONASS: - GNSS GPS:	-161 dBW; -158.5 dBW
7 Number of simulated NSC	At least 8 NSC for GLONASS; At least 8 NSC for GPS

Table D.2 — Basic parameters of script for simulation of speed-up to maximum velocity

Simulated parameter	Value
1 SS run time, hh:mm:ss	00:30:00
2 Initial point of IVDS in: - CKWGS-84; - PZ-90	Central Russia Central Russia
3 IVDS movement model: - speed-up to maximum velocity, km/h - acceleration, g	250 2
4 Parameters of navigation signal transmission medium: - troposphere; - ionosphere	Standard "Autumn" model
5 PDOP geometry factor	≤ 4
6 Simulated signals	GNSS GLONASS (L1 frequency range, SP code); GNSS GPS (L1 frequency range, C/A code); GNSS GLONASS/GPS
7 Minimum RF signal power: - GNSS GLONASS: - GNSS GPS:	-161 dBW; -158.5 dBW
8 Number of simulated NSC	At least 8 NSC for GLONASS; At least 8 NSC for GPS

Table D.3 — Basic parameters of script for simulation of movement with manoeuvring

Simulated parameter	Value
1 SS run time, hh:mm:ss	01:00:00
2 Initial point of IVDS in: - CKWGS-84; - PZ-90	Central Russia Central Russia
3 IVDS movement model: - velocity, m/s; - radius of turns, m; - acceleration at turns, m/s ²	Movement with manoeuvring 10 500 0.2
4 Parameters of NS transmission medium: - troposphere; - ionosphere	Standard "Spring" model
5 PDOP geometry factor	≤ 4
6 Simulated signals	GNSS GLONASS (L1 frequency range, SP code); GNSS GPS (L1 frequency range, C/A code); GNSS GLONASS/GPS
7 Minimum RF signal power: - GNSS GLONASS: - GNSS GPS:	-161 dBW; -158.5 dBW
8 Number of simulated NSC	At least 8 NSC for GLONASS; At least 8 NSC for GPS

Table D.4 — Basic parameters of script for simulation of movement in blockage and poor reception zones of navigation signals

Simulated parameter	Value
1 SS run time, hh:mm:ss	01:00:00
2 Initial point of IVDS in: - CKWGS-84; - PZ-90	Central Russia Central Russia
3 IVDS movement model: - maximum velocity, m/s	Movement with manoeuvring 10
4 NS radio visibility: - signal visibility intervals, s; - no signal intervals, s	300 600
5 Parameters of NS transmission medium: - troposphere; - ionosphere	Standard "Spring" model
6 PDOP geometry factor	≤ 4
7 Simulated signals	GNSS GLONASS (L1 frequency range, SP code); GNSS GPS (L1 frequency range, C/A code); GNSS GLONASS/GPS
8 Minimum RF signal power: - GNSS GLONASS: - GNSS GPS:	-161 dBW; -158.5 dBW
9 Number of simulated NSC	At least 8 NSC for GLONASS; At least 8 NSC for GPS

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