GLONASS/GPS/GALILEO/COMPASS/SBAS NV08C RECEIVER SERIES

BINR INTERFACE PROTOCOL SPECIFICATION

Version 1.3

Revision History

Version	Date	Description
1.0	Jan. 2012	First release of the document
1.1	Apr. 2012	General Editing
1.2	May 2012	A description of messages has been added to: – Antenna status and tests results request/response (11h/43h); – Raw data request/response; – Assisted-mode related messages.
1.3	Avg. 2012	General Editing

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1. Introductory Statement

This document describes the BINR proprietary binary data exchange protocol for the NV08C receivers series. Designation of the user's parameters as well as satellites and navigation information in the BINR protocol is provided in accordance with the designation of these parameters in the GPS and GLONASS ICDs.

1.1 Date and Time

For all messages (unless otherwise stated) time is represented as UTC, including the time zone shift entered in the 23h message. Time is represented as the number of seconds or milliseconds from the beginning of a week (determined by the data format used in the message). The Saturday to Sunday night, 00:00 hour shall be deemed as the beginning of a week.

The date also takes into account the time zone and is represented as week number starting from 22.08.1999 modulo 1024 (the 1024th week would be represented as 0, the 1025th as the 1st, etc.). A negative week number indicates that the date is undefined.

The time zone and coordinate system parameters for each protocol and port are controlled individually.

1.2 Coordinate System

Data format of the user's coordinates for BINR messages is defined by a coordinate system selected by the user. The altitude type (above the geoid or ellipsoid) is also determined by the user. Given this, the latitude and longitude are expressed in radians and the altitude is expressed in metres. The northern latitude and the eastern longitude are expressed by positive numbers and the southern latitude and the western longitude – by negative numbers.

The Gauss-Krueger rectangular projection employs the SK-42 (Pulkovo 42) coordinate system. The coordinates are transmitted as follows:

Instead of the latitude – Coordinate X in metres,

Instead of the longitude – Coordinate Y increased by 500000 expressed in metres, and the Time zone indicator multiplied by 1000000.

For example, if coordinates have been received:

Latitude of 5452812.5,

Longitude of 06417534.2,

Then it means that:

Time Zone indicator is 06

X = 5452812.5 metres

Y = 417534.2-500000= -82465.8 metres

The use of rectangular spatial coordinates may be selected in the protocol operating mode. In this case, coordinates are transmitted in metres from the center of the Earth:

Instead of the latitude – Coordinate X,

Instead of the longitude – Coordinate Y,

Instead of height – Coordinate Z.

Speed projections are also transmitted in rectangular spatial coordinates.

1.3 Default Settings

After powering up of the receiver module, the following settings take effect for the BINR protocol:

Coordinate System	WGS-84
Time	UTC
Coordinates	Geodesic
Height	Above sea level (geoid)

The above-mentioned settings are individual for each port, i.e., they affect the BINR message format for that port which was used for settings control.

The altered settings are not saved when module is switched off, i.e., after each device power on the BINR protocol always uses the settings given in the above default settings table.

2. Data Transmission Line

A bidirectional RS-232C serial interface (COM-port) is used for data transmission. Null-modem communication connection is used, i.e., only three lines are used: receive (RX), transmit (TX) and ground (GND).

The following COM-port settings are required for operation:

- 1 start bit
- 8 data bits
- 1 stop bit
- **Odd parity check**
- No Flow control

Transmission rate may be selected by the user within the range of 4800 to 230 400 bits per second.

Notes:

1. *The settings of the receiver module's ports for a specific protocol type and interface bit rate depend on the state of the configuration GPIOs and are specified in the module's data sheet. NV08C modules have the following default settings (when the configuration GPIOs are not connected or pulled to "ground"):*

   COM1 (UART A) – NMEA protocol, baud rate – 115,200 baud;

   COM2 (UART B) – BINR protocol, baud rate – 115,200 baud;

2. *The port default settings may be altered by the user and will automatically be saved in Back-up RAM. The settings configured by the user have a higher priority than GPIO state. I.e., if the Back-up RAM has user settings that are different than the settings determined by the state of GPIO, upon powering up, the ports will be set according to the BRAM's configuration.*

3. Format of Messages

3.1 BINR Message Structure

BINR messages have the following structure:

<DLE>	**<ID>**	**[data]**	**<DLE>**	**<CRC>**	**<CS>]**	**<DLE>**	**<ETX>**
1	2	3	4	5	6	7	8

Where:

№	Field	Purpose
1	<DLE>	1 byte, indicates the beginning of the service code (code 10 h or 00010000b)
2	<ID>	1 byte, message identifier; it may have any value but <DLE>, <ETX> and <CRC>
3	[data]	Optional part containing transmitted data
4	<CRC>	1 byte, indicates beginning of check sum field (code FFh or 11111111b)
5	<CS>	2 bytes, message check sum
6	<ETX>	1 byte, end-of-message indicator (code 03h or 00000011b)

If it is required to transmit a byte with a value of 10h (<DLE>) in the data field, then it will be repeated twice. All incoming double <DLE> symbols within data field must be compressed into single <DLE> byte before data decoding.

The <DLE><CRC><CS> check sum field is present in BINR messages only when the "check sum" mode is on (see Message B2h – Request for/Setting of BINR Protocol Operation Mode). If the check sum value contains the 10h (<DLE>) code, then it will be transmitted only once.

*Notes: By default, adding of check sum for BINR messages is **OFF**.*

Examples of messages without a check sum:

10	21	01	10	03
DLE	ID	data	DLE	ETX

10	60	0B	09	3E	4E	12	3F	11	39	60	3F	10	03
DLE	ID	data										DLE	ETX

Examples of messages with a check sum:

10	21	01	10	FF	F6	25	10	03
DLE	ID	data	DLE	CRC	CS		DLE	ETX

10	60	0B	09	F9	41	12	3F	58	80	5A	3F	10	FF	47	B3	10	03
DLE	ID	data										DLE	CRC	CS		DLE	ETX

3.2 Data Types Used

BINR messages contain integer types of data as well as floating-point types of data (see Table 1).

The formats of the floating point data types comply with the ANSI/IEEE Standard 754.

Integer data types are represented in complementary code.

For data consisting of several bytes, the lower bytes are transmitted first. The lower bits within a byte are also transmitted first.

Table 1. Formats of data types used.

Type	**Size, bit**	**Range of values**
INT8U	8	0 to 255
INT8S	8	-128 to 27
INT16U	16	0 to 65,535
INT16S	16	-32,768 to 32,767
INT32U	32	0 to 4,294,967,295
INT32S	32	2,147,483,648 to 2,147,483,647
FP32	32	$3.4 \cdot 10^{-38}$ to $3.4 \cdot 10^{38}$
FP64	64	$1.7 \cdot 10^{-308}$ to $1.7 \cdot 10^{308}$
FP80	80	$3.4 \cdot 10^{-493}$ to $3.4 \cdot 10^{4932}$

Note 1 – Tables with bit-to-bit structures of floating point data types are given in Appendix A.

Note 2 – Entry of INT8U[N] in the BINR message data fields, stands for an array consisting of N elements, each of which has an INT8U data type.

4. Data Transmission Check

4.1 Conditions for Processing Received Messages

Each message is processed in compliance with the message structure description. If the "check sum" mode is On, an additional check of the message's data fields' integrity is performed by way of comparing the calculated check sum and a received check sum. In the case of a checksum mismatch, the message must not be used.

As well, a message must contain data that does not go beyond acceptable limits (if such limits have been determined in the message description for this data field). If data goes beyond the acceptable limits, it may mean abnormal operation of the receiver module.

4.2 Check Sum Calculation Algorithm

The cyclical redundancy check function is used to validate the integrity of the message's data field. The BINR protocol uses one of the best known code seed – CCITT-16:

$$x^{16} + x^{12} + x^{5} + 1.$$

A check sum (CS) is calculated for all of the bytes in a message, starting from the message identifier <ID> down to the last byte before the service symbols of <DLE><CRC>, including repeated <DLE> in the data fields.

Appendix A shows an example of a C-language program for a table algorithm, as well as a program for calculating a code table for this method based on bit-by-bit algorithm. This example can be used to better understand the used redundancy check method.

5. Description of Protocol Functioning

5.1 Time Sequence Diagram

Navigation data transmitted by the receiver module in BINR messages is associated with the Navigation rate (1 − 10 Hz). The latitude and longitude values contained in the message N and corresponding to the time stamp N, depending on the message type, represent either coordinates received at the previous time interval or coordinates extrapolated to the given time interval. Velocity component values are not extrapolated. Extrapolation algorithm description is provided in Appendix A.

In the case of absence of transmission of high-priority messages, the reaction time to control messages will not exceed 100 milliseconds. The user shall not send the same query without having received a response from the receiver module.

Output of messages associated with the Navigation rate starts within 20 milliseconds after the end of the corresponding time interval. For clarification of the above-mentioned, Figure 1 shows a protocol time sequence diagram.

Note: The message output delay depends on the software version and may be different from 20 milliseconds.

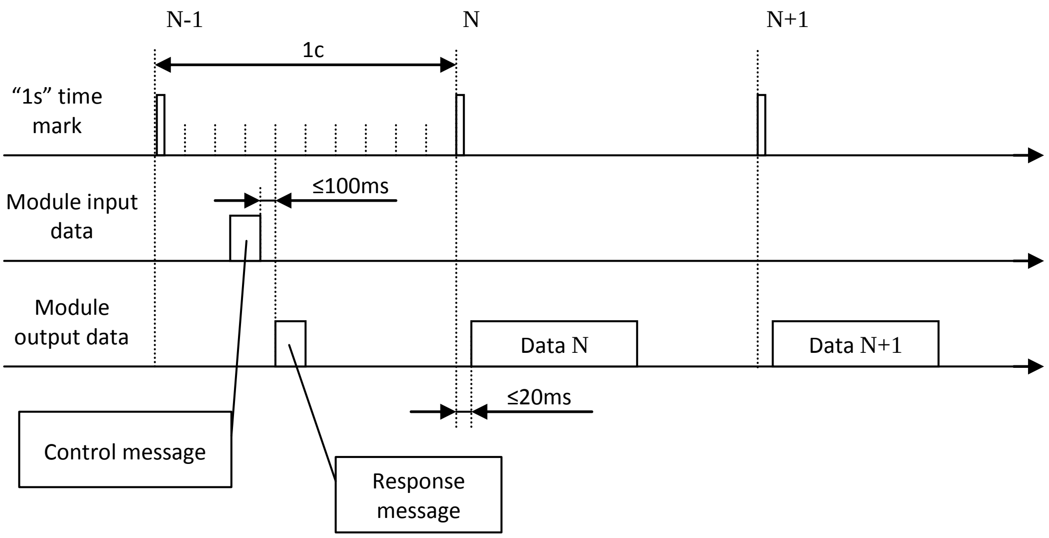

Figure 1. BIRN protocol time sequence diagram

Messages, whose output rate is associated with the navigation rate, have a higher output priority. These messages are transmitted first and in the same sequence as they were requested, then other messages are transmitted in the same manner.

The length of a message is limited to 1 KB. The overall length of all transmitted messages is limited to 3 KB. If the overall length of output messages exceeds 3 KB, then the next messages will be omitted. In this case, the messages whose output rate is associated with navigation rate will not be transmitted and the remaining messages will be transmitted when even possible. Thus in cases of transmission line overload due to too many message requests, priority will be given to messages containing navigation data with a rate enabled by the line throughput capability. The overall number of output messages is limited to 20.

Note: The message size as well as the overall size of messages and number of messages are defined by the software version and may differ from the above-mentioned.

If a message has been requested by different query messages, then the result will be determined by the last query message. For example, in the case of periodic message output, a one-time request will cancel the periodic output.

5.2 Port Operation Mode Changing

Changing of the current port settings (protocol type and/or line baud rate) will be made after the output of a response message (confirmation message) with the new port settings. The response message is not a high priority and will be delivered on a standard BINR message queue basis. The response message as well as all messages generated at the same time will be transmitted with the current port settings. The actual changing of the port settings will occur upon the end of the 100-millisecond internal time interval, once the output of these messages is complete.

6. Description of Types of Messages

6.1 Classification of Messages

BINR messages are divided into control messages (Queries), which are transmitted to the receiver module by the user and response messages which are then transmitted to the user from the receiver module.

The entire list of the BINR messages is represented in Table 2, Table 3 and Table 4.

Table 2. The list of main request and response messages

Query / Response Message	Direction	Item No	Brief Description
01h / –	→	6.2.1	Message 01h – Reboot
0Bh / 50h	←	6.2.2	Message 0Bh – Request for/Setting of a Port Status
	←	6.3.10	Message 50h – Query of the Current Port Status
0Dh / 51h	→	6.2.3	Message 0Dh – Setting of Receiver Operating Parameters
	←	6.3.11	Message 51h – Query of the Receiver Operating Parameters
0Eh / –	→	6.2.4	Message 0Eh – Cancellation of all Transmission Requests
0Fh / 55h	→	6.2.5	Message 0Fh – Setting of Reference Coordinates for the Fixed-Coordinates Operating Mode
	←	6.3.14	Message 55h – Query of the Status of Operating Mode with Averaged and Fixed Coordinates
11h / 43h	→	6.2.6	Message 11h – Test Results Request
	←	6.3.4	Message 43h – Test Results
12h / 47h	→	6.2.7	Message 12h – Enabling/Disabling of Satellite Used
	←	6.3.6	Message 47h – Enabling/Disabling of Satellite Used
13h / 41h*	→	6.2.8	Message 13h – Request for Course Angle and Actual Speed
	←	6.3.2	Message 41h – Course Angle and Actual Speed
17h / 42h	→	6.2.9	Message 17h – Request/Setting of Current Status of the Receiver Channels
	←	6.3.3	Message 42h – Current Status of Receiver Channels
19h / 49h	→	6.2.10	Message 19h – Request for/Loading of SV Ephemeris
	←	6.3.7	Message 49h – Satellite Ephemeris
1Bh / 70h	→	6.2.11	Message 1Bh – Request for Software Version
	←	6.3.18	Message 70h – Software Version
1Dh / 73h	→	6.2.12	Message 1Dh – Setting of Operating Modes for Coordinates and Delay in the Antenna Cable
	←	6.3.27	Message 73h – Time Synchronization Operating Mode
1Eh / 74h	→	6.2.13	Message 1Eh – Request for Time Scale Parameters

Query / Response Message	Direction	Item No	Brief Description
	←	6.3.21	Message 74h – Time Scale Parameters
1Fh / 72h	→	6.2.14	Message 1Fh – Request for Time and Frequency Parameters
	←	6.3.19	Message 72h – Time and Frequency Parameters
20h / 40h	→	6.2.15	Message 20h – Request for/Loading of an Almanac
	←	6.3.1	Message 40h – Almanac for the Specified Satellite
21h / 60h	→	6.2.16	Message 21h – Request for the Number of Satellites Used and DOP
	←	6.3.16	Message 60h – Number of Satellites Used and DOP
23h / 46h	→	6.2.17	Message 23h – Request for/Setting of the Time Zone
	←	6.3.5	Message 46h – Time, Date, Time Zone
24h / 52h	→	6.2.18	Message 24h – Request for Visible Satellites
	←	6.3.12	Message 52h – Visible Satellites
26h / 54h	→	6.2.19	Message 26h – Communication Check
	←	6.3.13	Message 54h – Response to Communication Check
27h / 88h*	→	6.2.20	Message 27h – Request for PVT Vector
	←	6.3.23	Message 88h – PVT vector
2Ah / 4Ah	→	6.2.21	Message 2Ah – Request for Ionosphere Parameters
	←	6.3.8	Message 4Ah – Ionosphere Parameters
2Bh / 4Bh	→	6.2.22	Message 2Bh – Request for GPS, GLONASS and UTC Time Scales Parameters
	←	6.3.9	Message 4Bh – GPS, GLONASS and UTC Time Scales Parameters
31h / 61h*	→	6.2.23	Message 31h – Request for the DOP and RMS for calculated PVT
	←	6.3.17	Message 61h – DOP and RMS for calculated PVT
35h / 93h	→	6.2.24	Message 35h – Request for Information about Used and Blocked Satellites
	←	6.3.24	Message 93h – Information about Used and Blocked Satellites
39h / 87h*	→	6.2.25	Message 39h – Request for Information on Receiver Channels
	←	6.3.22	Message 87h – Information on Receiver Channels
5Ch / 5Dh	→	6.2.26	Message 5Ch – Request for Atmospheric Corrections
	←	6.3.15	Message 5Dh – Atmospheric Corrections
A0h / A1h	→	6.2.27	Message A0h – Request for Results of Group Delay Calibration
	←	6.3.25	Message A1h – Used Group Delay Table
A2h / A3h	→	6.2.28	Message A2h – Request for/Installation of Coordinate System Parameters

Query / Response Message	Direction	Item No	Brief Description
	←	6.3.26	Message A3h – User Coordinate System
B2h / C2h	→	6.2.29	Message B2h – Request for/Setting of BINR Protocol Operation Mode
	←	6.3.27	Message C2h – BINR Protocol Status Word
D7h / E7h	→	6.2.30	Message D7h – Setting of Additional Operating Parameters
	←	6.3.28	Message E7h – Additional Operating Parameters
DBh / EBh	→	6.2.31	Message DBh – Request for GLONASS Time Scale Parameters
	←	6.3.29	Message EBh – GLONASS Time Scale Parameters

Note: The "" sign marks messages with output rates associated with Navigation rate*

The list of messages used by the receiver for request for/delivery of primary navigation (raw data) parameters is represented in Table 3.

Table 3. The list of messages used with raw data mode

Message	Direction	Item No	Brief Description
F4h	→	6.4.1	Message F4h – Request for Raw Data Output
F5h	←	6.4.2	Message F5h – Raw Data
F6h	←	6.4.3	Message F6h – Geocentric Coordinates of an Antenna in WGS-84 System
F7h	←	6.4.4	Message F7h – Extended Ephemeris of Satellites

The list of messages used by the receiver in Assisted Mode is represented in Table 4.

Table 4. The list of messages used in Assisted Mode

Message	Direction	Item No	Brief Description
6Fh	←	6.5.1	Message 6Fh – Request for Assisted Data
62h	→	6.5.2	Message 62h – Ephemeris
63h	→	6.5.3	Message 63h – Almanac
64h	→	6.5.4	Message 64h – Ionosphere Parameters
65h	→	6.5.5	Message 65h – Time Scales Parameters
69h	→	6.5.6	Message 69h – Differential Corrections
6Ah	→	6.5.7	Message 6Ah – Reference Location
6Bh	→	6.5.8	Message 6Bh – Reference Time

6.2 Control Messages

6.2.1 Message 01h – Reboot

This message requests a forced reboot of the device and erases all of the saved navigation and user data in accordance with value of parameter No 6. Message data content is permanent (see Table 5). The size of message is 6 bytes.

Table 5. The structure of 01h message data fields.

Parameter No	Offsetting, byte	Type	Parameter Description	Value
1	0	INT8U	Constant	00h
2	1	INT8U	Constant	01h
3	2	INT8U	Constant	21h
4	3	INT8U	Constant	01h
5	4	INT8U	Constant	00h
6	5	INT8U	Reboot Type	00h – with erasing 01h – without erasing

Examples:

Reboot without erasing of the saved system data and user settings (“Warm” Start):

10	01	00	01	21	01	00	01	10	03
DLE	ID	1	2	3	4	5	6	DLE	ETX

Reboot with erasing all saved parameters (“Cold” Start):

10	01	00	01	21	01	00	00	10	03
DLE	ID	1	2	3	4	5	6	DLE	ETX

6.2.2 Message 0Bh – Request for/Setting of a Port Status

The message requests or sets the exchange rate and the type of protocol used. Switching of a protocol and/or exchange speed is made after the delivery of response message **50h** with the new port settings to the user (Message 50h – Query of the Current Port Status).

In the case of a port status request, the message contains the port number only. The message shall not contain data in case of a current port status requests.

Message structure is shown in Table 6. Message data size – 0, 1 or 6 bytes.

Table 6. Structure of 0Bh message data fields

Parameter No	Offsetting, byte	Type	Parameter Description	Values
1	0	INT8U	Port No	0 – Current Port 1 – Port No1 (UART A) 2 – Port No2 (UART B)
2	1	INT32U	Exchange Speed	4'800 to 230'400 baud
3	5	INT8U	Protocol Type	0 – Current Protocol 1 – No protocol on this port 2 – NMEA Protocol 3 – RTCM Protocol 4 – BINR Protocol 5 – BINR2 Protocol

Examples:

Request for operation parameters of the current port:

10	0B	10	03
DLE	ID	DLE	ETX

Request for operation parameters of Port No1:

10	0B	01	10	03
DLE	ID	1	DLE	ETX

Switching of current port to BINR operating mode (115,200 baud):

10	0B	00	00	C2	01	00	04	10	03
DLE	ID	1	2				3	DLE	ETX

Switching of Port No 1 to 4,800 baud rate (NMEA protocol):

10	0B	01	C0	12	00	00	02	10	03
DLE	ID	1	2				3	DLE	ETX

6.2.3 Message 0Dh – Setting of Receiver Operating Parameters

This message requests and sets the following operating parameters of the receiver:

– The coordinate system used
– The satellite navigation systems used
– The PVT Settings

In the case of a request, the message contains no data. The setting is performed in compliance with the type of data specified in the first parameter. One sent message provides the settings of corresponding parameters for one type of data. The response message is message **51h** (Message 51h – Query of the Receiver Operating Parameters). The parameters are described in Table 7.

Message data size – 0 to 5 bytes.

Table 7. Structure of 0Dh message data fields

Parameter No	Offsetting, byte	Type	Parameter Description	Values
1	0	INT8U	Data Type	1 ÷ 4
Data Type = 1 Coordinate System Setting				
2	1	INT8U	Coordinate System	See Table 8
Data Type = 2 Selection of Satellite Navigation System(s) for operation				
2	1	INT8U	Operational Satellite Navigation System(s)	0 – GPS, GLONASS 1 – GPS 2 – GLONASS 3 – GALILEO 10 – GPS, GLONASS, SBAS 11 – GPS, SBAS 12 – GLONASS, SBAS
Data Type = 3 PVT Setting				
2	1	INT8U	The value of a minimum satellite elevation mask starting from which search and tracking will be provided (in degrees)	0 ÷ 90
3	2	INT8U	The minimum Signal-to-Noise Ratio for use in navigation	0 ÷ 39
4	3	INT16U	The maximum value of the root mean square error at which the navigation task shall be deemed valid (metres). The zero value of this parameter leaves the currently used RMS parameter value unchanged.	
Data Type = 4 Solution Filtering Parameter Setting				

Parameter No	Offsetting, byte	Type	Parameter Description	Values
2	1	FP32	Coordinates Filtration Factor	0 – Filtration is off 10 – Maximum value

Table 8. The coordinate systems used.

Code	Coordinate System	Reference Ellipsoid
00	WGS-84	WGS-84
01	PZ-90	PZ-90
02	Pulkovo 42 Coordinate System (SK-42)	Krassovsky
03	Pulkovo 95 Coordinate System (SK-95)	Krassovsky
04	PZ-90.02	PZ-90.02
F9h	User coordinate system No 1	
FAh	User coordinate system No 2	
FBh	User coordinate system No 3	
FCh	User coordinate system No 4	
FDh	User coordinate system No 5	
FEh	Gauss Kruger Rectangular Projection on SK-42	Krassovsky

Examples:

Switching to PZ-90 coordinate system:

10	0D	01	01	10	03
DLE	ID	1	2	DLE	ETX

Switching to GLONASS-only operating mode:

10	0D	02	02	10	03
DLE	ID	1	2	DLE	ETX

Setting of a minimum elevation angle at 5 degrees, minimum SNR level – at 30 dB-Hz, the minimum RMS error for coordinates at 200 m:

10	0D	03	05	1E	C8	00	10	03
DLE	ID	1	2	3	4		DLE	ETX

Setting of a coordinates filtration factor at 2:

10	0D	04	00	00	00	40	10	03
DLE	ID	1	2				DLE	ETX

6.2.4 Message 0Eh – Cancellation of all Transmission Requests

This message clears the list of output messages. It contains no data.

Example:

Cancellation of all transmission requests:

10	0E	10	03
DLE	ID	DLE	ETX

6.2.5 Message 0Fh – Setting of Reference Coordinates for the Fixed-Coordinates Operating Mode

This message is used for setting of reference antenna coordinates for fixed coordinates operating mode of device (see Table 9). The size of these messages is 25 bytes. The response message is message **55h** (Message 55h – Query of the Status of Operating Mode with Averaged and).

Table 9. Structure of 0Fh message data fields

Parameter No	Offsetting, byte	Type	Parameter Description	Value
1	0	INT8U	Data Type	3 [1] – Setting of coordinates for fixed-coordinates operating mode
2	1	FP64	Latitude, rad.	
3	9	FP64	Longitude, rad.	
4	17	FP64	Height, m.	
[1] – The value of a parameter differing from 3 is reserved for future use.				

Example:

Setting of reference coordinates for the fixed-coordinates operating mode:

Latitude = 30°25.0000' (0.530870980814942 radians), longitude = 60°50.0000'E (1.061741961629884 radians), altitude = 180.600m.

10	0F	03	1C	DC	9F	23	E5	FC	E0	3F	1C	DC	9F	23	E5	FC	F0	3F
DLE	ID	1	2								3							

33	33	33	33	33	93	66	40	10	03
4								DLE	ETX

6.2.6 Message 11h – Test Results Request

This message ((supported starting from FW version 02.04) requests internal test results (see Table 10). The response message is **43h** (Message 43h – Test Results) with results of internal tests.

Table 10. Structure of 11h message data fields

Parameter No	Offsetting, byte	Type	Description	Value
1	0	INT8U	Internal Test	0 – request/response a test results

Example:

Request for test results:

10	11	00	10	03
DLE	ID	1	DLE	ETX

6.2.7 Message 12h – Enabling/Disabling of Satellite Used

This message requests, enables or disables the use of specific satellite for navigation. The response message is **47h** (Message 47h – Enabling/Disabling of Satellite Used).

In the case of a request, the message contains no data. In the case of enabling/disabling of satellite using, the size of data is 3 bytes (see Table 11).

Table 11. Structure of 12h message data fields

Parameter No	Offsetting, byte	Type	Description	Values
1	0	INT8U	Satellite system	1 – GPS 2 – GLONASS
2	1	INT8U	Satellite Number	1÷32 for GPS 1÷24 for GLONASS
3	2	INT8U	Use	1 – enable 2 – disable

Examples:

Request of information about used satellites:

10	12	10	03
DLE	ID	DLE	ETX

Disabling of using for navigation a GPS satellite with PRN 10 (0Ah):

10	12	01	0A	02	10	03
DLE	ID	1	2	3	DLE	ETX

6.2.8 Message 13h – Request for Course Angle and Actual Speed

This message requests or disables the output of a message with course angle and actual speed values. The message contains 1 byte of data (see Table 12). In the case of a request for or cancellation of message a response **41h** message is sent (Message 41h – Course Angle and Actual Speed). In the case of a one-time delivery request, the message contains no data.

Table 12. Structure of 13h message data fields

Parameter No	Offsetting, byte	Type	Description	Values
1	0	INT8U	Disabling of message output	0
			Output rate in navigation rate intervals	1÷255

Examples:

Request for one-time response message with course angle and actual speed values:

10	13	10	03
DLE	ID	DLE	ETX

Setting of periodic output for 41h message once every 5 seconds (if navigation rate is 1Hz):

10	13	05	10	03
DLE	ID	1	DLE	ETX

6.2.9 Message 17h – Request/Setting of Current Status of the Receiver Channels

The 17h message requests the message **42h** (Message 42h – Current Status of Receiver Channels) with information on all the receiver channels, and may also forcedly make a specific channel to track a specific satellite. In this case, the channel is forced into the manual mode. The channel will stay in this mode until it is switched to the automatic mode or until the receiver is restarted.

If wrong parameters are set, the channel will be switched off!

In the case of a request, a message contains no data. In the case of parameters setting the message structure is shown in Table 13. The size of message is altered depending on presence of parameter № 5 and if it equals 4 or 8 bytes.

Table 13. Structure of 17h message data fields

Parameter No	Offsetting, byte	Type	Description	Values
1	0	INT8U	Channel Number	0 ÷ 31 [1]
2	1	INT8U	Satellite system	1 – GPS 2 – GLONASS 4 – SBAS
3	2	INT8U	SV number for GPS and SBAS	1 ÷ 32 for GPS 120 ÷ 138 for SBAS
		INT8S	A carrier frequency number for GLONASS	-7 ÷ +6
4	3	INT8U	Channel Status	0 – automatic 1 – manual
5	4	FP32	Doppler, Hz	Debug parameter (not recommended for use)
[1] – number of used channels may depend on the type of receiver				

Examples:

Request for the Current Status of the Receiver Channels:

10	17	10	03
DLE	ID	DLE	ETX

Switching of channel #10 of the receiver into the manual mode to a GLONASS satellite with -1 carrier frequency number:

10	17	09	02	FF	01	10	03
DLE	ID	1	2	3	4	DLE	ETX

6.2.10 Message 19h – Request for/Loading of SV Ephemeris

The 19h message requests or loads ephemerides of the specified satellite. In case of ephemeris request the message shall contain 2 bytes of data. For request for GLONASS ephemeris, 1 byte of data may be added to the message (carrier frequency number) because the GLONASS satellite number becomes known only after decoding the almanac. In this case, the ephemeris for the GLONASS satellite will also be output with an unknown satellite number but the satellite number in the request shall be set to zero.

Structure of this message is shown in Table 14. The message also allows to request for all the available ephemeris and to receive their updates (at the beginning of every hour for GPS, and at the beginning of every half-hour for GLONASS).

In the case of ephemeris loading the message structure is the same as response message **49h** (Message 49h – Satellite Ephemeris).

Table 14. Structure of 19h message data fields

Parameter No	Offsetting, byte	Type	Description	Values
Parameter No 1 equals 255.				
1	0	INT8U	Request for all ephemerides and updates thereof and addenda thereto.	255
2	1	INT8U	Disable of message output	0
			Output rate	1
Parameter No 1 does not equal 255				
1	0	INT8U	Satellite system	1 – GPS 2 – GLONASS
2	1	INT8U	Satellite Onboard Number	1 ÷ 32 for GPS 1 ÷ 24 for GLONASS
GLONASS Satellite System (optional)				
3	2	INT8S	Carrier frequency number for GLONASS	-7 ÷ +6

Examples:

Request for all the available ephemerides:

10	19	FF	01	10	03
DLE	ID	1	2	DLE	ETX

Request for GPS satellite ephemerides (SV number is 2):

10	19	01	02	10	03
DLE	ID	1	2	DLE	ETX

Request for GLONASS satellite ephemerides (SV carrier number -2):

10	19	02	FE	00	10	03
DLE	ID	1	2	3	DLE	ETX

6.2.11 Message 1Bh – Request for Software Version

Message requests for message **70h** (Message 70h – Software Version) with the software version. It contains no data.

Example:

Enquiry for software version (FW):

10	1B	10	03
DLE	ID	DLE	ETX

6.2.12 Message 1Dh – Setting of Operating Modes for Coordinates and Delay in the Antenna Cable

The 1Dh message sets operational parameters for coordinates and antenna cable delay (see Table 15). It is commonly used in time and frequency synchronization equipment. Message size depends on data type. The response message is message **73h** (Message 73h – Time Synchronization Operating Mode).

Table 15. Structure of 1Dh message data fields

Parameter No	Offsetting, byte	Type	Parameter Description	Value
1	0	INT8U	Data Type	0 – Operating mode setting 1 – Antenna cable delay entry 6 – Coordinate averaging time setting 7 – Entry of coordinates
0 – operating mode setting				
2	1	INT8U	Operating Mode	0 – Standalone Mode 1 – Mode with Fixed Coordinates 2 – Averaging of Coordinates
1 – setting of antenna cable delay				
2	1	FP64	Delay, milliseconds	
6 – setting of coordinate averaging time				
2	1	INT16U	Averaging time, minutes	
7 – setting of coordinates (geodesic WGS-84)				
2	1	FP64	Latitude, radians	
3	9	FP64	Longitude, radians	
4	17	FP64	Height, m	

Examples:

Setting of Coordinate Averaging Operating Mode:

10	1D	00	02	10	03
DLE	ID	1	2	DLE	ETX

Setting of Coordinate Averaging Time at 60 minutes:

10	1D	06	3C	00	10	03
DLE	ID	1	2		DLE	ETX

Antenna Cable Delay Setting at 200 nanoseconds:

10	1D	01	2D	43	1C	EB	E2	36	2A	3F	10	03
DLE	ID	1	2								DLE	ETX

6.2.13 Message 1Eh – Request for Time Scale Parameters

The 1Eh message requests the shift of the internal receiver time scale compare to the GLONASS, GPS, UTC (SU) and UTC time scales. It contains no data. The response message is message **74h** (Message 74h – Time Scale Parameters).

Example:

Request for parameters of internal time scale:

10	1E	10	03
DLE	ID	DLE	ETX

6.2.14 Message 1Fh – Request for Time and Frequency Parameters

The 1Fh message is used in time & frequency synchronization equipment. The response message is message **72h** (Message 72h – Time and Frequency Parameters). The message contains 1 byte of data in the case of a request for periodic message output (see Table 16), and does not contain data in the case of a one-time response.

Table 16. Structure of 1Fh message data fields

Parameter No	Offsetting, byte	Type	Description	Values
1	0	INT8U	Disable of message output	0
			Set output rate is 1 message per second	1

Examples:

Enquiry for one-time transmission of communication parameters of time and frequency:

10	1F	10	03
DLE	ID	DLE	ETX

Request for periodic output of 72h message at 1Hz rate:

10	1F	01	10	03
DLE	ID	1	DLE	ETX

6.2.15 Message 20h – Request for/Loading of an Almanac

This message requests almanac data for one satellite from the receiver or loads almanac data to the receiver.

In the case of a request for almanac data, a message contains 2 bytes of data (see Table 17).

In the case of loading of an almanac, the message structure is the same as for response message **40h** (Message 40h – Almanac for the Specified Satellite).

Table 17. Structure of 20h message data fields

Parameter No	Offsetting, byte	Type	Description	Values
1	0	INT8U	Satellite System	1 – GPS 2 – GLONASS
2	1	INT8U	Satellite Number	1 ÷ 32 for GPS 1 ÷ 24 for GLONASS

Examples:

Request for an almanac for a GPS satellite with SV number 10:

10	20	01	0A	10	03
DLE	ID	1	2	DLE	ETX

Request for an almanac for a GLONASS satellite with SV number 1:

10	20	02	01	10	03
DLE	ID	1	2	DLE	ETX

6.2.16 Message 21h – Request for the Number of Satellites Used and DOP

This message requests data regarding the number of GPS and GLONASS satellites utilized for Navigation as well as the value of the HDOP and VDOP geometric factors. The message contains 1 byte of data (see Table 18) in the case of a request for or cancellation of periodic output, and contains no data in the case of a request for single response. The response message is message **60h** (Message 60h – Number of Satellites Used and DOP).

Table 18. Structure of 21h message data fields

Parameter No	Offsetting, byte	Type	Description	Values
1	0	INT8U	Disable of message output	0
			Output rate, seconds	1 ÷ 255

Examples:

Request for one-time transmission of the number of satellites used for PTV calculation as well as the HDOP and VDOP geometric factors:

10	21	10	03
DLE	ID	DLE	ETX

Request for one-time delivery, at a rate of 5 seconds, of the number of satellites used for PVT calculation, as well as the HDOP and VDOP geometric factors:

10	21	05	10	03
DLE	ID	1	DLE	ETX

6.2.17 Message 23h – Request for/Setting of the Time Zone

This message requests for or sets the local time (zone) correction in relations to UTC. The correction is positive for eastern longitudes and negative for western longitudes. In the case of a request for the time zone, the message shall contain no data. The setting data is described in Table 19. The response message is message **46h** (Message 46h – Time, Date, Time Zone). The size of the message data is 2 bytes.

Table 19. Structure of 23h message data fields

Parameter No	Offsetting, byte	Type	Description	Values
1	0	INT8S	Hours	±13
2	1	INT8S	Minutes	±59

Notes: Time zone correction only influences delivery of information in the BINR format via the current port.

Examples:

Request for local time (zone) correction in relation to UTC:

10	23	10	03
DLE	ID	DLE	ETX

Setting of a correction of +10 hours 30 minutes of local time (zone) correction in relation to UTC:

10	23	0A	1E	10	03
DLE	ID	1	2	DLE	ETX

6.2.18 Message 24h – Request for Visible Satellites

This message requests the positions of the satellites related to the user. The response message **52h** (Message 52h – Visible Satellites) contains azimuths and elevation angles for all visible satellites. I.e. Satellites located above the horizon and with elevation angle exceeding the minimum value (see 0Dh – Setting of Receiver Operating Parameters). As well signal to noise ratios for all tracked satellites are also provided.

This message contains 1 byte of data (see Table 20) in the case of a request for or cancellation of periodic output, and contains no data in the case of a request for single response.

Table 20. Structure of 24h message data fields

Parameter No	Offsetting, byte	Type	Description	Values
1	0	INT8U	Disable of message output	0
			Output rate, seconds	1 ÷ 255

Examples:

Request for single 52h message:

10	24	10	03
DLE	ID	DLE	ETX

Request for periodic 52h output (every 5 seconds):

10	24	05	10	03
DLE	ID	1	DLE	ETX

6.2.19 Message 26h – Communication Check

This message is used to check the availability of communication with the receiver. Upon receiving this message, the receiver provides a single 54h response message output (Message 54h – Response to Communication Check). This message contains no data.

Example:

Communication availability check (request for message 54h delivery):

10	26	10	03
DLE	ID	DLE	ETX

6.2.20 Message 27h – Request for PVT Vector

This message requests/disables periodic output of a PVT vector. The response message is **88h** (Message 88h – PVT vector) contains a basic set of data describing the user's location: Date, time, coordinates, velocity, estimation of accuracy of coordinates and PVT calculation/extrapolation flag. One byte of data of the message determines the period of message output in intervals of Navigation rate (see Table 21). For request of single response the message should have no data.

Table 21. Structure of 27h message data fields

Parameter No	Offsetting, byte	Type	Description	Values
1	0	INT8U	Disable of message output	0
			Output rate, in intervals of navigation rate	1÷255

Examples:

Request for single 88h response message:

10	27	10	03
DLE	ID	DLE	ETX

Request for periodic output of 88h message at a rate which coinciding with Navigation rate:

10	27	01	10	03
DLE	ID	1	DLE	ETX

6.2.21 Message 2Ah – Request for Ionosphere Parameters

This message requests values of ionosphere parameters transmitted by the GPS system's satellites. The message contains 1 byte of data in the case of a request for, or cancellation of periodic output (see Table 22). It does not contain data in the case of a single request. The response message is **4Ah** (Message 4Ah – Ionosphere Parameters).

Table 22. Structure of 2Ah message data fields

Parameter No	Offsetting, byte	Type	Description	Values
1	0	INT8U	Disable of message output	0
			Output rate, seconds	1 ÷ 255

Examples:

A request for one-time transmission of a value of ionosphere parameters:

10	2A	10	03
DLE	ID	DLE	ETX

A request for periodic transmission (every 60 seconds) of a value of ionosphere parameters:

10	2A	3C	10	03
DLE	ID	1	DLE	ETX

6.2.22 Message 2Bh – Request for GPS, GLONASS and UTC Time Scales Parameters

This message requests data on the deviation of the time scales for GPS, GLONASS, UTC and UTC (SU) respectively. The data is transmitted by the satellites of the corresponding system. This message contains 1 byte of data in the case of a request for or cancellation of a periodic transmission (see Table 23), and it does not contain data in the case of a request for a one-time transmission. The response message is message **4Bh** (Message 4Bh – GPS, GLONASS and UTC Time Scales Parameters).

Table 23. Structure of 2Bh message data fields

Parameter No	Offsetting, byte	Type	Description	Values
1	0	INT8U	Disable of message output	0
			Output rate, seconds	1 ÷ 255

Examples:

A single request for 4Bh response message:

10	2B	10	03
DLE	ID	DLE	ETX

Request for a periodic output (every 60 seconds) of 4Bh message:

10	2B	3C	10	03
DLE	ID	1	DLE	ETX

6.2.23 Message 31h – Request for the DOP and RMS for calculated PVT

This message requests/disables periodic output of information regarding the DOP and components of root-mean square errors for calculated PVT. The response message is **61h** (Message 61h – DOP and RMS for calculated PVT). It is an addendum to message 88h (Message 88h – PVT vector).

One byte of data of the message determines the period of message output in intervals of navigation rate (see Table 24). In case of single request of message 61h, message 31h should have no data.

Table 24. Structure of 31h message data fields

Parameter No	Offsetting, byte	Type	Description	Values
1	0	INT8U	Disable of message output	0
			Output rate, seconds	1 ÷ 255

Examples:

A request for one-time transmission of information on GF and root mean square error:

10	31	10	03
DLE	ID	DLE	ETX

Request for periodic transmission (every 60 seconds) of information on GF and root mean square error:

10	31	3C	10	03
DLE	ID	1	DLE	ETX

6.2.24 Message 35h – Request for Information about Used and Blocked Satellites

Message is used for request of information about satellites that are used for navigation, as well as information about satellites that are blocked by RAIM. In the case of a request for or disabling of a period output of message 93h (Message 93h – Information about Used and Blocked Satellites), it contains 1 byte of data (see Table 25). In the case of a single request, the message contains no data.

Table 25. Structure of 35h message data fields

Parameter No	Offsetting, byte	Type	Description	Values
1	0	INT8U	Disable of message output	0
			Output rate, seconds	1 ÷ 255

Examples:

Request for one-time delivery of information on utilized and excluded satellites:

10	35	10	03
DLE	ID	DLE	ETX

Request for periodic transmission (every 60 seconds) of information on currently used and excluded satellites:

10	35	3C	10	03
DLE	ID	1	DLE	ETX

6.2.25 Message 39h – Request for Information on Receiver Channels

This message requests extended information on the status of the receiver channels. The response message is message **87h** (Message 87h – Information on Receiver Channels) which contains the satellites numbers (or carrier frequency number), information on the status of the channels and signal to noise ratio, as well as measurements of pseudo range and Doppler frequency.

This message contains 1 byte of data (see Table 26) in the case of a request for or disabling of periodic output, and contains no data in the case of a single request .

Table 26. Structure of 39h message data fields

Parameter No	Offsetting, byte	Type	Description	Values
1	0	INT8U	Disable of message output	0
			Output rate, seconds	1 ÷ 255

Examples:

Request for a one-time delivery of information on the status of receiver channels:

10	39	10	03
DLE	ID	DLE	ETX

Request for periodic transmission (every second) of information on the status of receiver channels:

10	39	01	10	03
DLE	ID	1	DLE	ETX

6.2.26 Message 5Ch – Request for Atmospheric Corrections

This message requests results of calculation of ionosphere and troposphere corrections for satellites used for navigation. The response message is message **5Dh** (Message 5Dh – Atmospheric Corrections), which contains the numbers of satellites used for PVT calculation as well as troposphere and ionosphere corrections to the range measurements.

A request message contains 1 byte of data (see Table 27) in the case of a request for or disabling of periodic output and it contains no data in the case of a single request.

Table 27. Structure of 5Ch message data fields

Parameter No	Offsetting, byte	Type	Description	Values
1	0	INT8U	Disable of message output	0
			Output rate, seconds	1 ÷ 255

Examples:

A request for one-time readout of results of calculation of ionosphere and troposphere corrections for satellites used to solve a navigation task:

10	5C	10	03
DLE	ID	DLE	ETX

A request for periodic transmission (every 60 seconds) of results of calculation of ionosphere and troposphere corrections for satellites used to solve a navigation task:

10	5C	3C	10	03
DLE	ID	1	DLE	ETX

6.2.27 Message A0h – Request for Results of Group Delay Calibration

This message enables the user to request a Group Delay table from the receiver or to load a Group Delay (GD) table into the receiver. The message size depends on request type (see Table 28). In the case of request for a table, the size of the data in a message is 2 bytes, in the case of loading a table – it is 90 bytes. The response message is message **A1h** (Message A1h – Used Group Delay Table).

Table 28. Structure of A0h message data fields

Parameter No	Offsetting, byte	Type	Description
1	0	INT8U	Request Type: 3 [1] – request for setting of a GD table values
2	1	INT8U	Table No: 1 [1] Default
3	2	FP32	GD for GLONASS with -7 carrier number, milliseconds
4	6	FP32	GD for GLONASS with -6 carrier number, milliseconds
5	10	FP32	GD for GLONASS with -5 carrier number, milliseconds
6	14	FP32	GD for GLONASS with -4 carrier number, milliseconds
7	18	FP32	GD for GLONASS with -3 carrier number, milliseconds
8	22	FP32	GD for GLONASS with -2 carrier number, milliseconds
9	26	FP32	GD for GLONASS with -1 carrier number, milliseconds
10	30	FP32	GD for GLONASS with 0 carrier number, milliseconds
11	34	FP32	GD for GLONASS with +1 carrier number, milliseconds
12	38	FP32	GD for GLONASS with +2 carrier number, milliseconds
13	42	FP32	GD for GLONASS with +3 carrier number, milliseconds
14	46	FP32	GD for GLONASS with +4 carrier number, milliseconds
15	50	FP32	GD for GLONASS with +5 carrier number, milliseconds
16	54	FP32	GD for GLONASS with +6 carrier number, milliseconds
17	58	FP32	Reserved
18	62	FP32	Reserved
19	66	FP32	Reserved
20	70	FP32	Reserved
21	74	FP32	Reserved
22	78	FP32	Reserved
23	82	FP32	Reserved
24	86	FP32	GD in the GPS path, milliseconds
[1] – Values of parameters differing from those given in the table are reserved for future use.			

6.2.28 Message A2h – Request for/Installation of Coordinate System Parameters

This message may be used to request for parameters of a coordinate system or to set parameters of a user coordinate system. The following table is assigned for user coordinate systems: 249÷253. In the case of a request, the message contains 1 byte of data and in case of setting – 43 bytes (see Table 29). The response message is message **A3h** (Message A3h – User Coordinate System).

Table 29. Structure of A2h message data fields

Parameter No	Offsetting, byte	Type	Designation	Description
1	0	INT8U		Coordinate System Index: 0 ÷ 255 (see Table 6)
2	1	FP32	Δa	Correction to the major semi-axis of ellipsoid WGS84, m
3	5	FP32	Δf	Correction of the compression ratio
4	9	FP32	ΔX	Mass Centre Offset, metres
5	13	FP32	ΔY	
6	17	FP32	ΔZ	
4	21	FP32	ωx	Axis turn angles, angle. min.
5	25	FP32	ωy	
6	29	FP32	ωz	
7	33	FP32	m	Difference among linear scales * 10^{-6}
8	37	INT8U[6]		System Name

Example:

Request for parameters of the PZ-90.02 coordinate system:

10	A2	04	10	03
DLE	ID	1	DLE	ETX

6.2.29 Message B2h – Request for/Setting of BINR Protocol Operation Mode

This message enables the user to change the BINR protocol operation mode. In the case of a request, the message contains no data. Values for setting the BINR protocol operation mode are given in Table 30. The size of the message data is 2 bytes. The response message is message **C2h** (Message C2h – BINR Protocol Status Word). In the case of enabling/disabling of Check Sum, changes will take effect upon receiving the **C2h** response message.

Table 30. Structure of B2h message data fields

Parameter No	Offsetting, byte	Type	Description	Value	
1	0	INT16U	BINR Protocol Status Word	Bit	Value
				0	Not used
				1	0 – Disable Check Sum 1 – Enable Check Sum
				2	0 – Altitude above the geoid 1 – Altitude above the ellipsoid
				3	0 – Geodetic Coordinates 1 – Rectangular Coordinates
				4 ÷ 15	Reserved

Examples:

Request for BINR protocol operation mode:

10	B2	10	03
DLE	ID	DLE	ETX

BINR protocol operation mode setting (Check Sum disabled, altitude above the ellipsoid, geodetic coordinates):

10	B2	04	10	03
DLE	ID	1	DLE	ETX

6.2.30 Message D7h – Setting of Additional Operating Parameters

This message requests and sets the following operating parameters of the receiver:

- User's Maximum Allowable Acceleration;
- Navigation Rate;
- Pseudo Range Smoothing Interval;
- PPS Control;
- Antenna Cable Delay;
- Navigation Operation Mode;
- Mode of Operation with Differential Corrections;
- Mode of Operation with Atmospheric Corrections;
- Priorities of Navigation Systems;
- Enabling/disabling to use SBAS to receive the remainder of message No 0;

The type of data being requested or uploaded is determined in the first parameter (see Table 31). In the case of a request, the message contains 1 byte of data. The response message is message **E7h** (Message E7h – Additional Operating Parameters). Message size depends on data type.

Table 31. Structure of D7h message data fields

<table>
<tr><th>Parameter No</th><th>Offsetting, byte</th><th>Type</th><th colspan="2">Parameter Description</th></tr>
<tr><td>1</td><td>0</td><td>INT8U</td><td colspan="2">Data Type: 1 ÷ 11</td></tr>
<tr><td colspan="5">Data Type = 1
User's Maximum Allowable Acceleration</td></tr>
<tr><td>2</td><td>1</td><td>FP32</td><td colspan="2">Maximum Allowable Acceleration 0.1 ÷ 100 m/sec^2</td></tr>
<tr><td colspan="5">Data Type = 2
Navigation Rate</td></tr>
<tr><td>2</td><td>1</td><td>INT8U</td><td colspan="2">Navigation rate: 1, 2, 5, 10 Hz</td></tr>
<tr><td colspan="5">Data Type = 3
Pseudo Range Smoothing Interval</td></tr>
<tr><td>2</td><td>1</td><td>INT16U</td><td colspan="2">Pseudo Range Smoothing Interval, seconds (not "0")</td></tr>
<tr><td colspan="5">Data Type = 5
PPS Control</td></tr>
<tr><td rowspan="4">2</td><td rowspan="4">1</td><td rowspan="4">INT8U</td><td>Bit</td><td>Value</td></tr>
<tr><td>0</td><td>0 – Software type (PPS)
1 – Hardware type (associated with the internal time scale of the receiver)</td></tr>
<tr><td>1</td><td>For software type only:
0 – Interval (with a Navigation rate)
1 – Every second</td></tr>
<tr><td>2</td><td>0 – Not verify PPS
1 – Verify PPS and disabling pulse generation in case PPS verification failed</td></tr>
</table>

Parameter No	Offsetting, byte	Type	Parameter Description	
			3	0 – Inverted 1 – Direct
			4÷7	PPS time stamp synchronization 1 – GPS 2 – GLONASS 3 – UTC 4 – UTC SU
3	2	INT8U	Keep the internal time scale within the ±1 milliseconds range from the UTC scale: 0 – Off 1 – On	
4	3	INT32U	PPS Length, nsec	
Data Type = 6 Antenna Cable Delay				
2	1	FP64	Delay, milliseconds	
Data Type = 7 Navigation Operation Mode				
2	1	INT16U	Bit	Value
			0	1 – Turn On RAIM 0 – Turn Off RAIM
			1	1 – Enable RAIM FDE 0 – Disable RAIM FDE
			2	1 – Disable 2D 0 – Enable 2D
			3	1 – Disable to use of single satellite of the satellite system 0 – Enable to use of single satellite of the satellite system
			4÷15	Reserved
Data Type = 8 Mode of Operation with Differential Corrections				
2	1	INT16U	Bit	Value
			0	1 – Enable the use of RTCM Corrections 0 – Disable
			1	1 – Enable use of SBAS Corrections 0 – Disable

Parameter No	Offsetting, byte	Type	Parameter Description	
			2	1 – Enable use of GBAS Corrections 0 – Disable
			3	Reserved
			4	1 – Disable Correction at ionosphere errors 0 – Enable
			5	1 – Disable Correction at troposphere errors 0 – Enable
			6-8	Reserved
			9	0 – Troposphere model according to SPS GPS 1 – Troposphere model according to RTCA
			10-15	Reserved
Data Type = 9 Reception Channels Distribution Among Satellite Systems				
2	1	INT8U	Default number of channels for GLONASS (used only for “cold start”)	
3	2	INT8U	Default number of channels for GPS (used only for “cold start”)	
4	3	INT8U	Default number of channels for SBAS	
Data Type = 11 Use of SBAS satellites operating in test mode				
2	1	INT8U	N = 0 to 255 If N is not “0” then test message SBAS No 0 shall be processed as SBAS message No N.	
Data Type = 12 Assisted Data Request On/Off				
2	1	INT8U	0 – Assisted Request Turn-off 1 – Assisted Request Turn-on	
Data Type = 13 RTCM Corrections’ Lifetime (not supported by version 03.00 and older)				
2	1	INT16U	RTCM Corrections’ Lifetime Duration, seconds	

Note: RTCM Corrections has priority over SBAS.

Examples:

Setting the Navigation rate at 5 Hz:

10	D7	02	05	10	03
DLE	ID	1	2	DLE	ETX

Pseudo range smoothing interval setting at 120 seconds:

10	D7	03	78	10	03
DLE	ID	1	2	DLE	ETX

Setting the PPS for 0.5 milliseconds length with synchronization to the UTC scale, with PPS verification and keeping the internal time scale within a range of ±1 millisecond from the UTC scale:

10	D7	05	3E	01	20	A1	07	00	10	03
DLE	ID	1	2	3	4				DLE	ETX

Setting the delay in the antenna cable at 50 nsec:

10	D7	06	2D	43	1C	EB	E2	36	0A	3F	10	03
DLE	ID	1	2								DLE	ETX

Setting a mode of operation with differential corrections (disabling of RTCM and SBAS corrections using):

10	D7	08	03	00	10	03
DLE	ID	1	2		DLE	ETX

Setting RTCM corrections' lifetime at 30 seconds:

10	D7	0D	1E	00	10	03
DLE	ID	1	2		DLE	ETX

6.2.31 Message DBh – Request for GLONASS Time Scale Parameters

This message requests GLONASS time scale parameters as transmitted in the GLONASS frame (see Table 32). The size of these messages is 1 byte. The response message is **EBh** (Message EBh – GLONASS Time Scale Parameters).

Table 32. Structure of DBh message data fields

Parameter No	Offsetting, byte	Type	Description	Values
1	0	INT8U	Disable of message output	0
			Output rate, seconds	1÷255

Example:

Request for time scale parameters' delivery – once every 60 seconds:

10	DB	3C	10	03
DLE	ID	1	DLE	ETX

6.3 Response Messages

6.3.1 Message 40h – Almanac for the Specified Satellite

This message is a response to message **20h** (Message 20h – Request for/Loading of an Almanac). This message transmits the almanac data for the specified satellite. In the case of absence of data, the message contains only the first two parameters of all of those described in Table 33. The size of the message data may be 2 bytes (no data), 60 bytes (GPS almanac) and 42 bytes (GLONASS almanac).

Table 33. Structure of 40h message data fields

Parameter No	Offsetting, byte	Type	Designation	Description	Value
1	0	INT8U		Satellite system	1 – GPS 2 – GLONASS
			GPS Satellite System		
2	1	INT8U	PRN	Satellite On-board Number	1÷32
3	2	INT8U	HELTH	Satellite Status	0 – Healthy
4	3	INT8U	PRN	On-board Number	1 ÷ 32
5	4	FP32	e	Orbit Eccentricity	
6	8	FP32	i_0	Orbit Inclination, rad.	
7	12	FP32	$\dot{\Omega}$	Ascending Mode Speed, rad. / millisecond	
8	16	FP64	$\sqrt{A}$	Square root of the major semi-axis of the orbit, $m^{1/2}$	
9	24	FP32	Ω_0	Ascending Node Longitude, rad.	
10	28	FP32	ω	Ascending node-perigee angle, rad.	
11	32	FP32	M_0	Mean anomaly per average time	
12	36	FP32	a_{f0}	Time Correction (Polynomial Factor), milliseconds	
13	40	FP32	a_{f1}	Time Correction (Polynomial Factor), milliseconds/milliseconds	
14	44	FP32	a_{f0l}	The upper part, af0 (for compatibility, 0 is transmitted), milliseconds	

Parameter No	Offsetting, byte	Type	Designation	Description	Value
15	48	FP80	t_{oa}	The almanac Reference Time, milliseconds, from week beginning	
16	58	INT16S	WN	GPS Week Number	Starting from 22.08.1999 modulo 1024
GLONASS Satellite System					
2	1	INT8U	n_a	On-board Number	1÷24
3	2	INT8U	C_n^A	Satellite Status	0 – Healthy
4	3	INT8U	H_n^A	The satellite carrier Frequency number (negative numbers are from 25 to 31)	
5	4	FP32	τ_n^A	The satellite time scale offset value in relation to the GLONASS scale, milliseconds	
6	8	FP32	λ_n^A	Orbit Ascending Node Longitude, rad.	
7	12	FP32	I	Orbit Inclination, rad.	
8	16	FP32	ε_n^A	Orbit Eccentricity	
9	20	FP32	ω_n^A	Orbit Ascending node-perigee angle, rad.	
10	24	FP32	t_n^A	The Orbit Ascending Node Passing Time, milliseconds	
11	28	FP64	T_n^A	Draconic (Nodical) Period, milliseconds/revolution	
12	36	FP32	(T_n^A)DOT	The Draconic (Nodical) Period Change Speed, milliseconds / revolution^2	
13	40	INT16U	N_a	Day Number in a 4-year period	

6.3.2 Message 41h – Course Angle and Actual Speed

This message is a response to message **13h** (Message 13h – Request for Course Angle and Actual Speed). This message contains extrapolated data of the course angle, actual speed and time. The data format of these messages is given in Table 34. The size of these messages is 12 bytes.

Table 34. Structure of 41h message data fields

Parameter No	Offsetting, byte	Type	Description
1	0	FP32	Course angle, speed
2	4	FP32	Speed, km/h
3	8	INT32U	Time from week beginning

6.3.3 Message 42h – Current Status of Receiver Channels

This message is a response to message **17h** (Message 17h – Request/Setting of Current Status of the Receiver Channels). This message data format is shown in Table 35, where the specified parameters are repeated for each channel of the receiver. The size of the message data is (5 * number of channels) bytes.

Table 35. Structure of 42h message data fields

Parameter No	Offsetting, byte	Type	Description	Values
1	0	INT8U	Satellite system	1 – GPS 2 – GLONASS 4 – SBAS 8 – Galileo E1b
2	1	INT8U	Number of Satellite for GPS and SBAS	1 ÷ 32 for GPS 120 ÷ 138 for SBAS
		INT8S	A carrier frequency slot number for GLONASS SV	-7 ÷ +6
3	2	INT8U	Signal/Noise Ratio	
4	3	INT8U	Channel Status	0 –Automatic Control 1 –Manual Control 2 –Being tested 3 –error
5	4	INT8U	Pseudo Range Sign	0 –There is a digitization and measurement of pseudo range 1 –Failure 2 –Pseudo Range measurement is available where the digitization is not.

6.3.4 Message 43h – Test Results

This message is a response to message 11h (Message 11h – Test Results Request). This message data are given in Table 36. The size of the message data is 6 bytes.

Table 36. Structure of 43h message.

Parameter No	Offsetting, byte	Type	Description	Value	
1	0	INT8U	Response Type	2 – Test Results	
2	1	INT8U	Test Results	Bit	
				0 to 3	Reserved
				4	GPS Test
				5	GLONASS Test
				7 to 6	Antenna Status: 0 – Antenna is connected 1 – Antenna is not connected 3 – Antenna short-circuited
3	2	INT32U	Reserved	0	

Examples:

Test result (no faults, the active antenna is connected):

10	43	02	00	00	00	00	00	10	03
DLE	ID	1	2	3				DLE	ETX

Test result (GPS channel error, the active antenna is connected):

10	43	02	10	00	00	00	00	10	03
DLE	ID	1	2	3				DLE	ETX

Test result (no faults, the active antenna is not connected):

10	43	02	80	00	00	00	00	10	03
DLE	ID	1	2	3				DLE	ETX

Test result (no faults, the active antenna is short-circuited):

10	43	02	C0	00	00	00	00	10	03
DLE	ID	1	2	3				DLE	ETX

6.3.5 Message 46h – Time, Date, Time Zone

This message is a response to message **23h** (Message 23h – Request for/Setting of the Time Zone). The format of this message is given in Table 37. Hours and minutes of time zone correction are added taking into the account their sign. The size of data of this message is 10 bytes.

Table 37. Structure of 46h message data fields

Parameter No	Offsetting, byte	Type	Description	Value
1	0	INT32U	Time from week beginning	
2	4	INT8U	Day	1÷31
3	5	INT8U	Month	1÷12
4	6	INT16U	Year	>1999
5	8	INT8S	Time Zone Correction, hours	±13
6	9	INT8S	Time Zone Correction, minutes	±59

6.3.6 Message 47h – Enabling/Disabling of Satellite Used

This message is a response to message **12h** (Message 12h – Enabling/Disabling of Satellite Used). The message contains information on enabling/disabling to use GPS and GLONASS satellites. The message transmits information on 32 GPS satellites and 24 GLONASS satellites. Data format for one satellite is given in Table 38. The size of data of this message: 3 * (32+24) = 168 bytes.

Table 38. Structure of 47h message data fields

Parameter No	Offsetting, byte	Type	Description	Values
1	0	INT8U	Satellite System	1 – GPS 2 – GLONASS
2	1	INT8U	Satellite On-board Number	1÷32 for GPS 1÷24 for GLONASS
3	2	INT8U	Use	1 – Enabled 2 – Disabled

6.3.7 Message 49h – Satellite Ephemeris

This message is a response to message **19h** (Message 19h – Request for/Loading of SV Ephemeris). The data format corresponds to Table 39. The size of the message data is 130 or 93 bytes.

Table 39. Structure of 49h message data fields

Parameter No	Offsetting, byte	Type	Designation	Description
1	0	INT8U		Satellite System: 1 – GPS 2 – GLONASS
GPS Satellite System				
2	1	INT8U	PRN	On-board Number: 1÷32
3	2	FP32	C_{rs}	Orbit Radius Sine Correction, meters
4	6	FP32	Δn	Difference between principal motion and defined motion, rad./milliseconds
5	10	FP64	M_0	Mean Anomaly, radians
6	18	FP32	C_{uc}	Longitude Argument Cosine Correction, radians
7	22	FP64	e	Eccentricity
8	30	FP32	C_{us}	Latitude Argument Sine Correction, radians
9	34	FP64	$\sqrt{A}$	Square root of the major semi-axis, $m^{1/2}$
10	42	FP64	t_{oe}	Ephemerides' Reference Time, milliseconds
11	50	FP32	C_{ic}	Cosine Correction to the Inclination angle, radians
12	54	FP64	Ω_0	Orbital Plane Ascending Node Longitude, radians
13	62	FP32	C_{is}	Sine Correction to the Inclination angle, radians
14	66	FP64	i_0	Inclination Angle, radians
15	74	FP32	C_{rc}	Orbit Radius Cosine Correction, metres
16	78	FP64	ω	Ascending node-perigee angle, radians
17	86	FP64	$\dot{\Omega}$	Direct Descending Change Speed, radians/milliseconds
18	94	FP64	IDOT	Inclination Angle Change Speed, radians/milliseconds
19	102	FP32	T_{GD}	Group Differential Delay Estimation, milliseconds

20	106	FP64	t_{oc}	Time Correction (Polynomial Factor), milliseconds
21	114	FP32	a_{f2}	Time Correction (Polynomial Factor), milliseconds/milliseconds^2
22	118	FP32	a_{f1}	Time Correction (Polynomial Factor), milliseconds/milliseconds
23	122	FP32	a_{f0}	Time Correction (Polynomial Factor), milliseconds
24	126	INT16U	URA	User Range Measurement Accuracy
25	128	INT16U	IODE	An Identifier of a Set of Ephemerides
GLONASS Satellite System				
2	1	INT8U	n^A	On-board Number: 1÷24, 0 – unknown
3	2	INT8S	H_n^A	Carrier frequency number
4	3	FP64	$x_n(t_b)$	Coordinates, m
5	11	FP64	$y_n(t_b)$	
6	19	FP64	$z_n(t_b)$	
7	27	FP64	$x'_n(t_b)$	Speeds, m/msec
8	35	FP64	$y'_n(t_b)$	
9	43	FP64	$z'_n(t_b)$	
10	51	FP64	$x''_n(t_b)$	Accelerations, m/msec^2
11	59	FP64	$y''_n(t_b)$	
12	67	FP64	$z''_n(t_b)$	
13	75	FP64	t_b	Time interval inside the current day, msec
14	83	FP32	$\gamma_n(t_b)$	Signal-carrier frequency value relative deviation
15	87	FP32	τ_n	The satellite time scale offset value in relation to the GLONASS scale, milliseconds
16	91	INT16U	E_n	Age of Ephemerides, days

6.3.8 Message 4Ah – Ionosphere Parameters

This message is a response to request message **2Ah** (Message 2Ah – Request for Ionosphere Parameters). This message contains ionosphere parameters transmitted by the GPS system satellites according to ICD-GPS-200. These messages are shown in Table 40. The size of the message is 33 bytes.

Table 40. Structure of 4Ah message data fields

Parameter No	Offsetting, byte	Type	Designation	Description
1	0	FP32	α_0	sec
2	4	FP32	α_1	Sec/semicycle
3	8	FP32	α_2	Sec/(semicycle)^2
4	12	FP32	α_3	Sec/(semicycle)^3
5	16	FP32	β_0	sec
6	20	FP32	β_1	Sec/semicycle
7	24	FP32	β_2	Sec/(semicycle)^2
8	28	FP32	β_3	Sec/(semicycle)^3
9	32	INT8U		Reliability Sign: 255 – the data is reliable

6.3.9 Message 4Bh – GPS, GLONASS and UTC Time Scales Parameters

This message is a response to request message **2Bh** (Message 2Bh – Request for GPS, GLONASS and UTC Time Scales Parameters. This message contains time scales parameters for GPS and UTC as well as GLONASS and UTC (SU) respectively (see Table 41).

Table 41. Structure of 4Bh message data fields

Parameter No	Offsetting, byte	Type	Designation	Description
1	0	FP64	A_1	Sec/sec
2	8	FP64	A_0	Sec
3	16	INT32U	t_{ot}	Sec
4	20	INT16U	WN_t	Weeks
5	22	INT16S	Δt_{LS}	Sec
6	24	INT16U	WN_{LSF}	Weeks
7	26	INT16U	DN	Days
8	28	INT16S	Δt_{LSF}	Sec
9	30	INT8U		Sign of reliability of data of communication of the GPS and UTC scales: 255 – the data is reliable
10	31	INT16U	N^A	The number of the day to which the τ_c time stamp refers
11	33	FP64	τ_c	Correction to GLONASS system time scale in relation to UTC(SU), sec
12	41	INT8U		Sign of reliability of data of communication of the GLONASS and UTC (SU) scales: 255 – the data is reliable

6.3.10 Message 50h – Query of the Current Port Status

This message is a response to request message **0Bh** (Message 0Bh – Request for/Setting of a Port Status). This message contains information on the requested port's operating mode (see Table 42). The size of these messages is 6 bytes.

Table 42. Structure of 50h message data fields

Parameter No	Offsetting, byte	Type	Parameter Description	Values
1	0	INT8U	Port No	1 – Port No1 (UART A) 2 – Port No2 (UART B)
2	1	INT32U	Port baud rate	4,800 ÷ 230,400
3	5	INT8U	Protocol Type	1 – No protocol used 2 – NMEA Protocol 3 – DIFF Protocol 4 – BINR Protocol 5 – BINR2 Protocol

Example:

The receiver port's current status (port No 1 (UART A), baud rate – 9'600 baud, NMEA protocol):

10	50	01	80 25 00 00	02	10	03
DLE	ID	1	2	3	DLE	ETX

6.3.11 Message 51h – Query of the Receiver Operating Parameters

This message is a response to request message **0Dh** (Message 0Dh – Setting of Receiver Operating Parameters). This message contains current operating parameters of the receiver (see Table 43). The size of data of these messages is 11 bytes.

Table 43. Structure of 51h message data fields

Parameter No	Offsetting, byte	Type	Parameter Description	Values
1	0	INT8U	Operational Satellite Navigation System	See 0Dh Message – Setting of Operating Parameters
2	1	INT8U	Reserved	0
3	2	INT8U	Coordinate System	See Table 8
4	3	INT8S	The value of a minimum satellite height mask, starting from which search and tracking will be performed, degrees 0÷90°	
5	4	INT8U	Minimum SNR level for use in navigation	
6	5	INT16U	The maximum value of the root mean square error at which solution of a navigation task shall be deemed valid (metres).	
7	7	FP32	Solution Filtration Degree	

Example:

The current parameters of the receiver operation (working satellite navigation system – GPS/GLONASS; the coordinate system is WGS-84; the minimum elevation angle value is 5°, the minimum SNR level is 17dB, the maximum root mean square error value is 250 metres and the solution filtration degree is 3):

10	51	00	00	00	05	11	C8 00	00 00 40 40	10	03
DLE	ID	1	2	3	4	5	6	7	DLE	ETX

6.3.12 Message 52h – Visible Satellites

This message is a response to request message **24h** (Message 24h – Request for Visible Satellites). Response message 52h (Table 44) contains azimuths and elevation angles for all the satellites located above the horizon with elevation angle exceeding the minimum value (see Message 0Dh – Setting of Receiver Operating Parameters) as well as the signal/noise ratio for all tracked satellites. The message structure is shown in Table 44. The size of these messages is [7 * the number of visible satellites] bytes and, in case of absence of information, the message contains no data.

Table 44. Structure of 52h message data fields

Parameter No	Offsetting, byte	Type	Description	Values
1	0	INT8U	Satellite system	1 – GPS 2 – GLONASS 4 – SBAS
2	1	INT8U	Satellite On-board Number	1÷32 for GPS 1÷24 for GLONASS 120÷138 for SBAS
3	2	INT8S	Carrier Frequency slot Number	-7 ÷ +6 for GLONASS FFh for GPS and SBAS
4	3	INT8U	Satellite Height Mask, degrees	0÷90
5	4	INT16U	Azimuth, degrees	0÷359
6	6	INT8U	Signal/Noise Ratio	

Examples:

Information on visible satellites is not available:

10	52	10	03
DLE	ID	DLE	ETX

6.3.13 Message 54h – Response to Communication Check

This message is a response to request message **26h** (Message 26h – Communication Check). Message contains no data.

Example:

Hand Shaking:

10	54	10	03
DLE	ID	DLE	ETX

6.3.14 Message 55h – Query of the Status of Operating Mode with Averaged and Fixed Coordinates

This message is a response to request message 0Fh (0Fh Message - Entry of Reference Coordinates for the Fixed-Coordinates Operating Mode). It is used in time, and time and frequency synchronization equipment, and contains information on the state of the operating mode with averaged and fixed coordinates (see Table 45). The size of these messages is 11 bytes.

Table 45. Structure of 55h message data fields

Parameter No	Offsetting, byte	Type	Parameter Description	Values
1	0	INT8U	Operating Mode	0 – Standalone Mode 1 – Mode with Fixed Coordinates 2 – Averaging of Coordinates
2	1	FP64	Delay in Antenna Cable, msec	
3	9	INT16U	Averaging time, minutes	

6.3.15 Message 5Dh – Atmospheric Corrections

This message is a response to the request message **5Ch** (Message 5Ch – Request for Atmospheric Corrections). This message contains the numbers of the satellites used for navigation, and ionosphere and troposphere corrections to range measurements. The message structure is given in Table 46. The size of the message data fields is (1+14 * number of satellites) bytes.

Table 46. Structure of 5Dh message data fields

Parameter No	Offsetting, byte	Type	Description	Values
1	0	INT8U	Number of satellites in the message	
The next fields are repeated for every satellite				
2	1	INT8U	Satellite system	1 – GPS 2 – GLONASS 4 – SBAS
3	2	INT8U	Satellite Number	1÷32 for GPS 1÷24 for GLONASS 120÷138 for SBAS
4	3	FP32	Troposphere delay, m	
5	7	FP32	Ionosphere delay, m	
6	11	FP32	Reserved[1]	
[1] – The parameter is reserved for use in double-frequency receivers for ionosphere delay calculated by L1/L2 measurements.				

6.3.16 Message 60h – Number of Satellites Used and DOP

This message is a response to the request message **21h** (Message 21h – Request for the Number of Satellites Used and DOP This message contains the number of GPS and GLONASS satellites used for navigation as well as the value of HDOP and VDOP geometric factors (see Table 47). The size of this message is 10 bytes.

Table 47. Structure of 60h message data fields

Parameter No	Offsetting, byte	Type	Description	Value
1	0	INT8U	Number of GPS Satellites	
2	1	INT8U	Number of GLONASS Satellites	
3	2	FP32	HDOP	
4	6	FP32	VDOP	

6.3.17 Message 61h – DOP and RMS for calculated PVT

This message is a response to the request message **31h** (Message 31h – Request for the DOP and RMS for calculated PVT). The message contains information on all the components of the geometrical factor (DOP) as well as an estimation of coordinates and speed of the last calculated PVT. This message is an addendum to message **88h** (Message 88h – PVT vector). The structure of message 61h is represented in Table 48. The size of this message is 288 bytes.

Table 48. Structure of 61h message data fields

Parameter No	Offsetting, byte	Type	Description	Value
1	0	FP32	HDOP	
2	4	FP32	VDOP	
3	8	FP32	TDOP	
4	12	FP32	Estimation of an error in terms of latitude, m	
5	16	FP32	Estimation of an error in terms of longitude, m	
6	20	FP32	Estimation of an error in terms of altitude, m	
7	24	FP32	Estimation of a speed error in terms of latitude, m	
8	28	FP32	Estimation of a speed error in terms of longitude, m	
9	32	FP32	Estimation of a speed error in terms of altitude, m	

6.3.18 Message 70h – Software Version

This message is a response to the request message **1Bh** (Message 1Bh – Request for Software Version). This message contains information regarding the overall number of correlation channels, as well as the version of the device's hardware and software (see Table 49). The size of these messages is 76 bytes.

Table 49. Structure of 70h message data fields

Parameter No	Offset, byte	Type	Description	Value
1	0	INT8U	Number of Channels	
2	1	INT8U[21]	Equipment and Software Version Identifier	21-byte long text field
3	22	INT32U	Serial Number (device ID)	
4	26	INT8U[21]	Reserved	21-byte long text field
5	47	INT32U	Reserved	
6	51	INT8U[21]	Reserved	21-byte long text field
7	72	INT32U	Reserved	

Note: Reserved fields may contain extra information depending on the device modification and the software version.

6.3.19 Message 72h – Time and Frequency Parameters

This message is a response to the request message 1Fh (Message 1Fh – Request for Time and Frequency Parameters). It is used in time, and time and frequency synchronization equipment and contains data on the current time and date, statistical values of parameters of the reference generator, deviation of GPS scale from UTC scale (see Table 50). The size of this message is 34 bytes.

Table 50. Structure of 72h message data fields

Parameter No	Offsetting, byte	Type	Description	Value
1	0	FP80	Current time from beginning of week, ms	
2	10	INT16S	GPS Week Number	Starting from 22.08.1999 modulo 1024
3	12	INT8U	Time Scale Type	0 – GLONASS Scale 1 – GPS Scale 2 – UTC (SU) 3 – UTC
4	13	FP64	Deviation of the Reference Generator Period	
5	21	FP64	Current deviation of time stamp from the true scale, ns	
6	29	INT16U	GPS Scale Deviation from UTC Scale, sec	
7	31	INT8U	Not used	
8	32	INT16U	Not used	

6.3.20 Message 73h – Time Synchronization Operating Mode

This message is a response to the request message **1Dh** (Message 1Dh – Setting of Operating Modes for Coordinates and Delay in the Antenna Cable). This message is used in time & frequency synchronization equipment. The message size is 11 bytes (see Table 51).

Table 51. Structure of 73h message data fields

Parameter No	Offsetting, byte	Type	Description	Value
1	0	INT8S	Mode of Operation with Coordinates	0 – Dynamic 1 – with fixed coordinates 2 – with averaging
2	1	FP64	Time Stamp Formation Delay, ms	
3	11	INT16S	Coordinates Averaging Time, Minutes	20 to 1440

Note: The dynamic mode is used by default and presupposes simultaneous calculation of coordinates and time. The other two modes are recommended for use in timing applications. The mode with fixed coordinates is used when the user knows the exact coordinates of the antenna installation. The averaging mode presupposes preliminary estimation of antenna installation coordinates by way of averaging the coordinates calculated by the receiver during a pre-set period of time. Having accomplished the averaging of coordinates, the receiving automatically switches over to the mode with fixed coordinates.

6.3.21 Message 74h – Time Scale Parameters

This message is a response to the request message **1Eh** (Message 1Eh – Request for Time Scale Parameters). This message contains information on shifts between different time scales with validity flags of them. The size of this message is 51 bytes (see Table 52).

Table 52. Structure of 74h message data fields

Parameter No	Offsetting, byte	Type	Description		Value
1	0	FP80	GPS scale shift from the receiver internal time scale, ms		
2	10	FP80	GLONASS scale shift from the receiver internal time scale (regardless of 3 hours' offset), ms		
3	20	FP80	GPS Scale shift from UTC Scale, msec		
4	30	FP80	GLONASS scale shift from UTC(SU) scale, ms		
5	40	FP80	GPS scale shift from GLONASS scale (regardless of 3 hours' offset), ms		
6	50	INT8U	Data validity flags		
			Bit	Value	
			0	GPS time is valid	
			1	GLONASS time is valid	
			2	UTC time is valid	
			3	UTC (SU) time is valid	

6.3.22 Message 87h – Information on Receiver Channels

This message is a response to the request message **39h** (Message 39h – Request for Information on Receiver Channels). The size of this message data is [20 * number of channels] bytes (see Table 53).

Table 53. Structure of 87h message data fields

Parameter No	Offsetting, byte	Type	Description	Value
1	0	INT8U	Satellite system	1 – GPS 2 – GLONASS 4 – SBAS 8 – Galileo E1b
2	1	INT8S	Number of Satellite for GPS and SBAS. A carrier frequency slot number for GLONASS	1÷32 for GPS 120÷138 for SBAS 1÷32 for GALILEO -7 ÷ +6 for GLONASS
3	2	INT8U	Signal/Noise Ratio	
4	3	INT8U	Channel Status	0 – Automatic Control 1 – Manual Control 2 – Being tested 3 – Failure
5	4	INT16U	Channel Status:	
			Bit	Value
			0	Signal/Noise Value Availability
			1	Range and Doppler Availability
			2	Smoothed Range Availability
			3	Phase Availability
			4	Digitization Availability
			5	Bit Synchronization Availability
			6	The type of sampler used: 0 – Level-sensitive sampler (Wide) 1 – Narrow
			7	Reserved
			8	Availability of Ephemerides
			9	Almanac Availability
			10	Reserved
			11	GLONASS-M flag
			12	The measurements come into PVT calculation
			13	The measurements were used in PVT calculation
			14	Reserved

			15	The measurements are blocked by RAIM check
6	6	FP64	The measured range within the code epoch limits	
7	14	FP32	Doppler, Hz	
8	18	INT16S	Pseudo Range Sign	1 – There is a digitization and measurement of pseudo range 0 – failure 1 – No digitization, pseudo range measurement is available

6.3.23 Message 88h – PVT vector

This message is a response to the request message 27h (Message 27h – Request for PVT Vector). This message contains extrapolated coordinates, speeds, date, the time of the calculated coordinates, the root mean square error of the coordinates, the PVT status (see Table 54). The size of these messages is 69 bytes.

Table 54. Structure of 88h message data fields

<table>
<tr><th>Parameter No</th><th>Offsetting, byte</th><th>Type</th><th colspan="2">Description</th><th>Value</th></tr>
<tr><td>1</td><td>0</td><td>FP64</td><td colspan="2">Latitude, rad.[1]</td><td></td></tr>
<tr><td>2</td><td>8</td><td>FP64</td><td colspan="2">Longitude, rad.[1]</td><td></td></tr>
<tr><td>3</td><td>16</td><td>FP64</td><td colspan="2">Height, m[1]</td><td></td></tr>
<tr><td>4</td><td>24</td><td>FP32</td><td colspan="2">Root Mean Square Error of plane coordinates, m</td><td></td></tr>
<tr><td>5</td><td>28</td><td>FP80</td><td colspan="2">Time of determination from beginning of week, ms</td><td></td></tr>
<tr><td>6</td><td>38</td><td>INT16S</td><td colspan="2">GPS Week Number</td><td></td></tr>
<tr><td>7</td><td>40</td><td>FP64</td><td colspan="2">Speed in terms of latitude[1]</td><td></td></tr>
<tr><td>8</td><td>48</td><td>FP64</td><td colspan="2">Speed in terms of longitude[1]</td><td></td></tr>
<tr><td>9</td><td>56</td><td>FP64</td><td colspan="2">Speed in terms of altitude[1]</td><td></td></tr>
<tr><td>10</td><td>64</td><td>FP32</td><td colspan="2">Deviation of the Reference Generator Period, ms per second</td><td></td></tr>
<tr><td rowspan="10">11</td><td rowspan="10">68</td><td rowspan="10">INT8U</td><td colspan="2">Solution Status</td><td></td></tr>
<tr><td>Bit</td><td>Value</td><td></td></tr>
<tr><td>0</td><td>0 – No solution was obtained at the previous interval
1 – A solution was obtained at the previous interval</td><td></td></tr>
<tr><td>1</td><td>1 – A 2D navigation mode was obtained</td><td></td></tr>
<tr><td>2</td><td>Reserved</td><td></td></tr>
<tr><td>3</td><td>1 – Differential corrections were used in the solution</td><td></td></tr>
<tr><td>4</td><td>1 – Confirmation of data by RAIM check</td><td></td></tr>
<tr><td>5</td><td>1 – Mode of Operation with Differential Corrections</td><td></td></tr>
<tr><td>6</td><td>Reserved</td><td></td></tr>
<tr><td>7</td><td>Not used</td><td></td></tr>
<tr><td colspan="6">[1] – The delivery (readout) format for Gauss-Kruger SK or rectangular spatial coordinates systems is described in the General Provisions.</td></tr>
</table>

6.3.24 Message 93h – Information about Used and Blocked Satellites

This message is a response to the request message **35h** (Message 35h – Request for Information about Used and Blocked Satellites). This message contains information on the status of the Navigation fix, numbers of satellites used in the Navigation fix, numbers and value of range errors of blocked satellites (see Table 55).

Table 55. Structure of 93h message data fields

Parameter No	Offsetting, byte	Type	Description	Value
1	0	INT32U	Solution Status	
			Bit	Value
			0	Reliable Solution Obtained
			1	2D navigation fix Obtained
			2	1D navigation fix Obtained
			3	Use of RTCM Correction
			4	Solution passed RAIM check
			5	Reference Station Mode
			6	External data were used (for example, Barometric altitude)
			7	Anomaly found
			8	Reserved
			9	GPS satellites used in the Navigation fix
			10	GLONASS satellites used in the Navigation fix
			11	SBAS satellites used in the Navigation fix
			12	GALILEO satellites used in the Navigation fix
			13	SBAS corrections used in the Navigation fix
			14	GBAS corrections used in the Navigation fix
			15	The root mean square error of the coordinates is lower than the maximum allowable figure
			16-31	Reserved
2	4	INT32U	GPS satellites being used Each satellite has its corresponding bit in the word: The 0^{th} bit corresponds to The 1^{st} PRN; the 31^{st} bit – to the 32^{nd} PRN. 1 – the satellite used in the PVT calculation 0 – the satellite not used in the PVT calculation	
3	8	INT32U	GLONASS satellites being used Each satellite has its corresponding bit in the word: The 0^{th} bit corresponds to The 1^{st} GLONASS board The 23^{rd} bit – to the 24^{th} GLONASS board.	

4	12	INT32U	SBAS satellites being used Each satellite has its corresponding bit in the word. The 0^{th} bit corresponds to The 120^{th} PRN; the 18^{th} bit – to the 138^{th} PRN.	
The next fields are repeated for each excluded satellite				
5	16	INT8U	Satellite Number	1÷32 – GPS 65÷88 – GLONASS
6	17	FP32	Range Error, m	

6.3.25 Message A1h – Used Group Delay Table

This message is a response to the request message **A0h** (Message A0h – Request for Results of Group Delay Calibration) and contains information on the Group Delay (GD) table used in the receiver. The format of this message is given in Table 56.

Table 56. Structure of A1h message data fields

Parameter No	Offsetting, byte	Type	Description
1	0	INT8U	Response Type: 3 [1] – requested GD table
2	1	INT8U	Table No: 1 [1] Default
3	2	FP32	GD for GLONASS with -7 carrier number milliseconds
4	6	FP32	GD for GLONASS with -6 carrier number, milliseconds
5	10	FP32	GD for GLONASS with -5 carrier number, milliseconds
6	14	FP32	GD for GLONASS with -4 carrier number, milliseconds
7	18	FP32	GD for GLONASS with -3 carrier number, milliseconds
8	22	FP32	GD for GLONASS with -2 carrier number, milliseconds
9	26	FP32	GD for GLONASS with -1 carrier number, milliseconds
10	30	FP32	GD for GLONASS with 0 carrier number, milliseconds
11	34	FP32	GD for GLONASS with +1 carrier number, milliseconds
12	38	FP32	GD for GLONASS with +2 carrier number, milliseconds
13	42	FP32	GD for GLONASS with +3 carrier number, milliseconds
14	46	FP32	GD for GLONASS with +4 carrier number, milliseconds
15	50	FP32	GD for GLONASS with +5 carrier number, milliseconds
16	54	FP32	GD for GLONASS with +6 carrier number, milliseconds
17	58	FP32	Reserved
18	62	FP32	Reserved
19	66	FP32	Reserved
20	70	FP32	Reserved
21	74	FP32	Reserved
22	78	FP32	Reserved
23	82	FP32	Reserved
24	86	FP32	GD in the GPS path, milliseconds
[1] – Values of parameters differing from those given in the table are reserved for future use			

6.3.26 Message A3h – User Coordinate System

This message is a response to the request message **A2h** (Message A2h – Request for/Installation of Coordinate System Parameters) and contains information on the user's coordinate system. The message format corresponds to the request message A2h.

6.3.27 Message C2h – BINR Protocol Status Word

This message is a response to the request message **B2h** (Message B2h – Request for/Setting of BINR Protocol Operation Mode) and contains the BINR protocol status word. The message format corresponds to the request message B2h specified in Table 30.

6.3.28 Message E7h – Additional Operating Parameters

This message is a response to the request message **D7h** (D7h – Setting of Additional Operating Parameters). This message delivers additional operation parameters of the receiver in compliance with the type of requested data. The message format corresponds to the request message and is specified in Table 31.

6.3.29 Message EBh – GLONASS Time Scale Parameters

This message is a response to the request message **DBh** (Message DBh – Request for GLONASS Time Scale Parameters). Information on GLONASS time scale parameters (see Table 57). The contents of the data transmitted in this message correspond to GLONASS 5.1 document control index. The size of this message data is 26 bytes.

Table 57. Structure of EBh message data fields

Parameter No	Offsetting, byte	Type	Parameter Description	Values
1	0	FP64	τ_c	Correction to GLONASS system time scale in relation to UTC(SU) Correction τ_c is given as of beginning of day No N^A.
2	8	FP32	τ_{GPS}	Correction to deviation of GPS (T_{GPS}) and GLONASS (T_{GL}) system time scales according to the following equation: $T_{GPS} - T_{GL} = \Delta T + \tau_{GPS}$, Where ΔT is an integer part and τ_{GPS} is a fractional part of divergence of time scales expressed in seconds. Notes: The integer part of ΔT divergence is determined by the GPS system navigational message.
3	12	INT16U	N^A	Calendar number of a day inside a four-year period beginning from a leap year to which the τ_c correction refers and the system almanac data (almanac of orbits and almanac of phases).
4	14	INT8U	N_4	The number of a four-year period. The first year of the first four-year period Corresponds to year 1996.
5	15	INT8U	Reliability of Parameters 1-4	0 – Parameters are not reliable ≠0 – Parameters are reliable
6	16	INT8U	KP*	The sign of expected second correction of the UTC scale by a value of ±1 s.
7	17	FP32	B1**	The ΔUT1 as of the beginning of day No N^A is measured in seconds.
8	21	FP32	B2**	The ΔUT1 parameter alteration speed is measured in seconds over a mean solar day (sec/msd).
9	25	INT8U	Reliability of Parameters 6-8	0 – Parameters are not reliable ≠0 – Parameters are reliable
* – The KP sign is placed into the navigation frame no later than in 8 weeks prior to correction.				

However, decision on a forthcoming correction may be taken earlier then in 8 weeks. That is why, from the beginning of a quarter, prior to decision taking, a sign of “10” (the decision has not been made yet) is transmitted and, after the decision has been taken, one of the first signs of the table below is transmitted:

KP	Information on UTC second correction
00	At the end of the current quarter, there will be no UTC
01	At the end of the current quarter, there will be a correction by plus 1 s.
11	At the end of the current quarter, there will be a correction by minus 1 s.

** – Words B1 and B2 are linear polynomial factors for determination of ΔUT1 value of divergence of the global UT1 (the time of Greenwich meridian considering pole motion) and coordinated time (UTC(SU)) of the RF state standard: ΔUT1 = UT1 - UTC(SU).

6.4 Messages Containing Raw Data Information

Raw data (pseudorange, carrier phase and Doppler) output is supported starting from FW v.02.04.

6.4.1 Message F4h – Request for Raw Data Output

This message requests raw data output (see Table 58). The size of data field of this message is 1 byte.

The response to the request is represented by the following messages:

- **70h** (Message 70h – Software Version) – single message;
- **4Ah** (Message 4Ah – Ionosphere Parameters) – with an interval of 2 minutes;
- **4Bh** (Message 4Bh – GPS, GLONASS and UTC Time Scales Parameters) – with an interval of 2 minutes;
- **F5h** (Message F5h – Raw Data) – with a requested interval defined in message F4h;
- **F6h** (Message F6h – Geocentric Coordinates of an Antenna in WGS-84 System) – with an interval of 1 minute;
- **F7h** (Message F7h – Extended Ephemeris of Satellites) – with an interval of updating of ephemerides.

Table 58. Structure of F4h message data fields

Parameter No	Offsetting, byte	Type	Description	Values
1	0	INT8U	Measurement Interval, in 100-millisecond intervals	10 (by default) 10*100ms = 1 sec

Example:

Request for raw data output with a measurement interval of 2 seconds (20 intervals of 100 ms each):

10	F4	14	10	03
DLE	ID	1	DLE	ETX

6.4.2 Message F5h – Raw Data

This message is a response to the request message **F4h** (Message F4h – Request for Raw Data Output). This message contains raw data measurements: pseudorange, carrier phase, Doppler and SNR (see Table 59). The size of the message data is [28 + (30 * number of channels used)] bytes.

Table 59. Structure of F5h message data fields

Parameter No	Offsetting, byte	Type	Parameter Description	Values
1	0	FP64	Time of measurements, ms (UTC)	
2	8	INT16U	Week Number	
3	10	FP64	GPS-UTC time shift, ms	
4	18	FP64	GLONASS-UTC time shift, ms	
5	26	INT8S	Receiver Time Scale Correction, ms	
Raw Measurements (the data provided are for one channel of the receiver[1])				
6	27	INT8U	Signal Type [2]	
7	28	INT8U	Satellite Number	
8	29	INT8U	A carrier number for GLONASS	
9	30	INT8U	Signal-to-Noise Ratio, dB-Hz	
10	31	FP64	Carrier Phase, cycles	
11	39	FP64	Pseudo Range, ms	
12	47	FP64	Doppler Frequency, Hz	
13	55	INT8U	Raw Data Flags [3]	
14	56	INT8U	Reserved	

[1] – The message contains measurements to received satellites only.

[2] – The signal type is determined by the mask:

0x01 – GLONASS

0x02 – GPS

0x04 – SBAS

[3] – Measurement Flags are determined by the mask:

0x01 – Signal present (tracking)

0x02 – Millisecond pseudorange/Doppler Frequency Measurements present

0x04 – Pseudorange measurements are smoothed

0x08 – Carrier Phase measurements present

0x10 – Signal time is available (full pseudo range)

0x20 – The preamble was not detected (half-cycle ambiguity for the carrier phase). This flag is supported starting from NV08C software version 02.05.

6.4.3 Message F6h – Geocentric Coordinates of an Antenna in WGS-84 System

This message is a response to the request message **F4h** (Message F4h – Request for Raw Data Output). Message F6h contains Geocentric Coordinates of Antenna in WGS-84 System (see Table 60). The size of data fields in this message is 26 bytes.

Table 60. Structure of F6h message data fields

Parameter No	Offsetting, byte	Type	Parameter Description	Values
1	0	FP64	X, m	
2	8	FP64	Y, m	
3	16	FP64	Z, m	
4	24	FP64	Root mean square error of X [1], m	
5	32	FP64	Root mean square error of Y [1], m	
6	40	FP64	Root mean square error of Z [1], m	
7	48	INT8U	Flag of user dynamic	0 – Static mode 1 – Kinematic mode
[1] – Expected root mean square error for each coordinates component				

6.4.4 Message F7h – Extended Ephemeris of Satellites

This message is a response to the request message F4h (Message F4h – Request for Raw Data Output). This message contains extended ephemeris of satellites (see Table 60). The size of data fields of the message is 138 bytes for GLONASS satellites and 93 bytes for GPS satellites.

Table 61. Structure of F7h message data fields

Parameter No	Offsetting, byte	Type	Parameter Description	Values
1	0	INT8U	Satellite System Type	1 – GPS 2 – GLONASS
2	1	INT8U	Satellite Number	
GPS Ephemeris				
3	2	FP32	C_{rs} , m	Crs
4	6	FP32	Δn , radians/ms	Dn
5	10	FP64	M_0 , radians	M0
6	18	FP32	C_{uc} , radians	Cuc
7	22	FP64	e	E
8	30	FP32	C_{us} , radians	Cus
9	34	FP64	$\sqrt{A}$, $m^{1/2}$	SqrtA
10	42	FP64	t_{oe} , ms	Toe
11	50	FP32	C_{ic} , radians	Cic
12	54	FP64	Ω_0 , radians	Omega0
13	62	FP32	C_{is} , radians	Cis
14	66	FP64	i_0 , radians	I0
15	74	FP32	C_{rc} , m	Crc
16	78	FP64	ω , radians	W
17	86	FP64	$\dot{\Omega}$, radians /ms	OmegaR
18	94	FP64	IDOT, radians /ms	Ir
19	102	FP32	T_{GD} , ms	Tgd
20	106	FP64	t_{oc} , ms	Toc
21	114	FP32	a_{f2} , ms/ms^2	Af2
22	118	FP32	a_{f1} , ms/ms	Af1
23	122	FP32	a_{f0} , ms	Af0
24	126	INT16U	URA	
25	128	INT16U	IODE	
26	130	INT16U	IODC	

27	132	INT16U	C/A OR P ON L2	CodeL2
28	134	INT16U	L2 P DATA FLAG	L2_Pdata_flag
29	136	INT16U	WN	WeekN
GLONASS Ephemeris				
3	2	INT8S	Carrier number	
4	3	FP64	$x_n(t_b)$, m	X, m
5	11	FP64	$y_n(t_b)$, m	Y, m
6	19	FP64	$z_n(t_b)$, m	Z, m
7	27	FP64	$x'_n(t_b)$, m/ms	Vx, m/ms
8	35	FP64	$y'_n(t_b)$, m/ms	Vy, m/ms
9	43	FP64	$z'_n(t_b)$, m/ms	Vz, m/ms
10	51	FP64	$x''_n(t_b)$, m/ms^2	Ax, m/ms^2
11	59	FP64	$y''_n(t_b)$, m/ms^2	Ay, m/ms^2
12	67	FP64	$z''_n(t_b)$, m/ms^2	Az, m/ms^2
13	75	FP64	$t_{b,}$, ms	
14	83	FP32	$\gamma_n(t_b)$	
15	87	FP32	$\tau_n(t_b)$, ms	
16	91	INT16U	E_n	

6.4.5 Message D5h – Request for Bit Information Transmitted by Satellites

This message requests output of bit information transmitted by satellites (see Table 62). The size of data fields of this message is 1 byte. The response message is the **E5h** (Message E5h – Bit Information Transmitted by Satellites).

Table 62. Structure of D5h message data fields

Parameter No	Offsetting, byte	Type	Description
1	0	INT8U	0 – Disable of bit data output 1 – Enable of bit data output

Example:

Request for E5h message output:

10	D5	01	10	03
DLE	ID	1	DLE	ETX

6.4.6 Message E5h – Bit Information Transmitted by Satellites

This message is a response to the request message **D5h** (Message D5h – Request for Bit Information Transmitted by Satellites). This message contains completely received lines and sub-frames for all tracked satellites.

In the case of request for bit information output, every second the receiver checks the availability of (GLONASS) lines and (GPS/SBAS) sub-frames that are completely received at present second. When they are available, the receiver provides an output of a response E5h message containing all of the completely received lines and sub-frames for all tracked satellites.

The format of this message is given in Table 63.

Table 63. Structure of E5h message data fields

Parameter No	Offsetting, byte	Type	Description
1	0	INT8U	Number of data blocks transmitted in a message (number of complete lines and sub-frames)
GLONASS Data			
2	1	INT8U	The number of the channel that tracks the satellite
3	2	INT8U	SNS Type: 1 for GLONASS
4	3	INT8U	GLONASS Carrier number -7 to +6
5	4	INT32U	Time in the receiver time scale, corresponding to the moment of completing the reception of a data bit line
6	8	INT8U[3]	85-bit (2-second) line of GLONASS data (without a time mark and after removal of the 100Hz-meander modulation)
GPS Data			
2	1	INT8U	The number of the channel that tracks satellite
3	2	INT8U	SNS Type: 2 for GPS
4	3	INT8U	GPS Satellite Number: 1 to 32
5	4	INT32U	Time in the receiver time scale, corresponding to the moment of completing the reception of a bit data sub-frame
6	8	INT8U[10]	An array containing a 300-bit (6-second) GPS sub-frame Each 32-position word contains 30 bits of data. The MSB of each word contains the 1st bit of a 30-bit word contained in the sub-frame. Two LSBs of each word are not used (they contain two high bits of the following 30-bit word).
SBAS Data			
2	1	INT8U	The number of the channel that tracks the satellite

3	2	INT8U	SNS Type: 4 for SBAS
4	3	INT8U	SBAS Satellite number: 0 to 18 (0 corresponds to SBAS #120)
5	4	INT32U	Time in the receiver time scale, corresponding to the moment of completing the reception of a bit data sub-frame
6	8	INT8U[8]	An array containing a 250-bit (6-second) SBAS sub-frame The MSB of the 1st 32-bit word contains the 1st bit of the sub-frame, the MSB of the 2nd 32-bit word – the 33rd bit of the sub-frame,… the MSB of the 8th 32-bit word contains the 225th bit of the sub-frame; 6 LSBs of the 8th 32-bit word are not used.

Note: The parameters 2-6 in the E5h message are repeated for all satellites for which accumulation of a data lines/sub-frames have been completed. The overall number of such satellites is determined by the first parameter in a message.

6.5 Assisted Messages

The Assisted mode of the receiver can be used to reduce the Time to First Fix, to enhance sensitivity of signal acquisitions, as well as to provide a differential operating mode. Assisted data is intended to be loaded from a NVS server. However, the same messages may be prepared by the user to interface to third-party assisted data services.

Activation/deactivation of the Assisted mode is performed via a control message **D7h** (Message D7h – Setting of Additional Operating Parameters, Data type = 9). In response to this message, every second the receiver provides output of 6Fh response message, containing information on parameters which are required by the receiver for fast signal search and Navigation fix. Differential correction data is not requested in the 6Fh message, but when the Assisted Mode is activated, this data may be transmitted to the receiver without request and they will be used automatically.

The following messages are supported in the Assisted Mode:

- **62h** (Message 62h – Ephemeris). It contains information on ephemeris for GPS and GLONASS satellites;
- **63h** (Message 63h – Almanac). It contains information on an almanac for GPS and GLONASS satellites;
- **64h** (Message 64h – Ionosphere Parameters). It contains information on an ionosphere model;
- **65h** (Message 65h – Time Scales). It contains information on GPS-UTC and GLONASS-UTC (SU) time scales parameters;
- **69h** (Message 69h – Differential Corrections). It is supposed for sending of differential corrections into a receiver for both GPS and GLONASS satellites;
- **6Ah** (Message 6Ah – Reference Location). It contains information on approximate user location;
- **6Bh** (Message 6Bh – Reference Time). It contains information on the current time.

6.5.1 Message 6Fh – Request for Assisted Data

This message provides information on the parameters and data required by the receiver for fast signal search and Navigation fix. This message is transmitted every second with Assisted Mode activated (Message D7h – Setting of Additional Operating Parameters, data type = 9).

The message contains 7 bytes of data (see Table 64).

Table 64. Structure of 6Fh message data fields

<table>
<tr><th>Parameter No</th><th>Offsetting, byte</th><th>Type</th><th>Description</th><th colspan="2">Values</th></tr>
<tr><td>1</td><td>0</td><td>INT8U</td><td>Request Flag</td><td colspan="2">= 2 (by default)
Flag values other than “2” are reserved.</td></tr>
<tr><td rowspan="10">2</td><td rowspan="10">1</td><td rowspan="10">INT16U</td><td rowspan="10">Requested Data</td><td>Bit</td><td>Value</td></tr>
<tr><td>0</td><td>Request for Reference Location</td></tr>
<tr><td>1</td><td>Request for Reference Time</td></tr>
<tr><td>2</td><td>Request for Ionosphere Parameters</td></tr>
<tr><td>3</td><td>Request for Time Scales Parameters</td></tr>
<tr><td>4</td><td>Request for GLONASS Almanac</td></tr>
<tr><td>5</td><td>Request for GPS Almanac</td></tr>
<tr><td>6</td><td>Request for GLONASS Ephemeris</td></tr>
<tr><td>7</td><td>Request for GPS Ephemeris</td></tr>
<tr><td>8÷15</td><td>Reserved</td></tr>
<tr><td>3</td><td>3</td><td>INT32U</td><td>Reserved</td><td colspan="2"></td></tr>
</table>

Note: Differential correction data in message 6Fh is not requested, but when the Assisted Mode is activated, this data may be transmitted to the receiver without a request and they will be used automatically.

6.5.2 Message 62h – Ephemeris

This message is used to send information on GLONASS and GPS satellites' ephemeris to the receiver. This message contains information on ephemerides for one satellite only. The structure of message 62h is shown in Table 65. The size of data of the message is 54 bytes for GPS ephemeris and 34 bytes for GLONASS ephemeris.

Table 65. Structure of 62h message data fields

Parameter No	Offsetting, byte (bit)	Type	Description	Value
1	0	INT8U	Type of Ephemerides	1 – GPS 2 – GLONASS
GPS Ephemerides				
2	1	INT8U	PRN - 1	
3	2	INT8U	Status	0 (by default)
Three Sub-frames of GPS Ephemerides [1]				
The First Sub-Frame of GPS Ephemerides				
4	3 (24)	10-bit	WN	WN
5	(34)	2-bit	C/A OR P ON L2	CodeL2
6	(36)	4-bit	URA INDEX	URA
7	(40)	6-bit	SV HEALTH	Health
8	(46)	2-bit	IODC (two high-order positions)	
9	(48)	1-bit	L2 P DATA FLAG	
10	(49)	87-bit	Reserved	
11	(136)	8-bit	T_{GD}	Tgd
12	(144)	8-bit	IODC (8 low-order positions)	
13	(152)	16-bit	t_{oc}	Toc
14	(168)	8-bit	a_{f2}	Af2
15	(176)	16-bit	a_{f1}	Af1
16	(192)	22-bit	a_{f0}	Af0
17	(214)	2-bit	t	
The Second Sub-Frame of GPS Ephemerides				
18	(216)	8-bit	IODE	
19	(224)	16-bit	C_{rs}	Crs
20	(240)	16-bit	Δn	Dn
21	(256)	32-bit	M_0	M0
22	(288)	16-bit	C_{uc}	Cuc

23	(304)	32-bit	e	E
24	(336)	16-bit	C_{us}	Cus
25	(352)	32-bit	$\sqrt{A}$	SqrtA
26	(384)	16-bit	t_{oe}	Toe
27	(400)	1-bit	FIT INTERVAL FLAG	
28	(401)	5-bit	AODO	
29	(406)	2-bit	t	
The Third Sub-Frame of GPS Ephemerides				
30	(408)	16-bit	C_{ic}	Cic
31	(424)	32-bit	Ω_0	Omega0
32	(456)	16-bit	C_{is}	Cis
33	(472)	32-bit	i_0	I0
34	(504)	16-bit	C_{rc}	Crc
35	(520)	32-bit	ω	W
36	(552)	24-bit	$\dot{\Omega}$	OmegaR
37	(576)	8-bit	IODE	
38	(584)	14-bit	IDOT	Ir
39	(598)	2-bit	t	
GLONASS Ephemerides [2]				
4	3 (24)	INT8U	PRN - 1	
5	4 (32)	3-bit	B_n	Bn
6	(35)	7-bit	t_b	Toe
7	(42)	22-bit	$\tau_n(t_b)$	Tau
8	8 (64)	11-bit	$\gamma_n(t_b)$	Gamma
9	(75)	5-bit	$\Delta\tau_n$	deltaTau
10	10 (80)	5-bit	E_n	E_n
11	(85)	2-bit	P1	P1
12	(87)	1-bit	P2	P2
13	11 (88)	2-bit	M	M
14	(90)	27-bit	$x_n(t_b)$	Px
15	(117)	24-bit	$x'_n(t_b)$	Vx
16	(141)	5-bit	$x''_n(t_b)$	Ax
17	(146)	27-bit	$y_n(t_b)$	Py

18	(173)	24-bit	$y'_n(t_b)$	Vy
19	(197)	5-bit	$y''_n(t_b)$	Ay
20	(202)	27-bit	$z_n(t_b)$	Pz
21	(229)	24-bit	$z'_n(t_b)$	Vz
22	(253)	5-bit	$z''_n(t_b)$	Az
23	(258)	14-bit	Reserved	

[1] – GPS ephemerides are represented as three sub-frames packed into one bit line without check sums and without the first two words in each sub-frame.

[2] – Data for GLONASS are represented in the form of 8 consecutive INT32U-type words. During reception, words should be sequentially buffered and then corresponding bit fields should be extracted.

6.5.3 Message 63h – Almanac

This message is used to send GPS and GLONASS satellites' almanac to the receiver. The structure of message 63h is shown in Table 66.

Table 66. Structure of 63h message data fields

Parameter No	Offsetting, byte (bit)	Type	Description	Value
1	0	INT8U	Almanac Type	1 – GPS 2 – GLONASS
GPS Almanac				
2	1	INT8U	WN	Week Number, starting from 22.08.1999 modulo 1024
Further goes N entry for every Satellite				
3	2 + N*25	INT8U	dataID	
4	3 + N*25	INT8U	PRN	
5	4 + N*25	INT16U	e	E
6	6 + N*25	INT8U	t_{oa}	Toa
7	7 + N*25	INT16U	δi	Deltai
8	9 + N*25	INT16U	$\dot{\Omega}$	omegaR
9	11 + N*25	INT8U	SV HEALTH	Health
10	12 + N*25	24-bit	$\sqrt{A}$	SqrtA
11	15 + N*25	24-bit	Ω_0	Omega0
12	18 + N*25	24-bit	M_0	M0
13	21 + N*25	24-bit	ω	W
14	24 + N*25	11-bit	a_{f0}	Af0
15		11-bit	a_{f1}	Af1
GLONASS Almanac [1]				
Further goes N entry for every Satellite				
3	1 + N*20	11-bit	N^A	Na
4		5-bit	n^A	PRN
5		5-bit	$\Delta H^A{}_n$	Ha
6		21-bit	$\lambda^A{}_n$	Lambda
7		21-bit	$\tau^A_{\lambda^n}$	tlambda
8		18-bit	$\Delta i^A{}_n$	deltai
9		22-bit	$\Delta T^A{}_n$	deltaT

10		7-bit	$\Delta T'^{A}_{n}$	RdeltaT
11		15-bit	ε^{A}_{n}	E
12		16-bit	ω^{A}_{n}	W
13		10-bit	τ^{A}_{n}	Tau
14		1-bit	C_n	Cn
15		2-bit	M_n^a	M
16		16-bit		Reserved
[1] – Data for GLONASS are transmitted in the form of 5 consecutive INT32U-type words. During reception, words should be sequentially buffered and then corresponding bit fields should be extracted.				

6.5.4 Message 64h – Ionosphere Parameters

This message is used to send ionosphere model information to the receiver. The structure of message 64h is shown in Table 67. The size of data in this message is 9 bytes.

Table 67. Structure of 64h message data fields

Parameter No	Offsetting, byte	Type	Description	Value
1	0	INT8U	Model Type	1 – GPS
2	1	INT8S	α_0	Alpha[0]
3	2	INT8S	α_1	Alpha[1]
4	3	INT8S	α_2	Alpha[2]
5	4	INT8S	α_3	Alpha[3]
6	5	INT8S	β_0	Beta[0]
7	6	INT8S	β_1	Beta[1]
8	7	INT8S	β_2	Beta[2]
9	8	INT8S	β_3	Beta[3]

Note: Parameters of ionosphere have the same format in which they are transmitted in a navigation signal.

6.5.5 Message 65h – Time Scales Parameters

This message is used to send GPS-UTC and GLONASS-UTC (SU) time scales parameters to the receiver. The structure of message 65h is shown in Table 68. The size of data in the message is 14 bytes for GPS parameters and 13 bytes for GLONASS parameters.

Table 68. Structure of 65h message data fields

Parameter No	Offsetting, byte (bit)	Type	Description	Value
1	0	INT8U	Type of Parameters	1 – GPS-UTC 2 – GLONASS-UTC
GPS-UTC				
2	1	24-bit	A_1	
3	4	INT32S	A_0	
4	8	INT8U	t_{ot}	
5	9	INT8U	WN_t	
6	10	INT8S	Δt_{LS}	
7	11	INT8U	WN_{LSF}	
8	12	INT8U	DN	
9	13	INT8S	Δt_{LSF}	
GLONASS-UTC(SU) [1]				
2	1 (8)	11-bit	N^A	
3	(19)	32-bit	τ_c	
4	(51)	11-bit	B1	
5	(61)	10-bit	B2	
6	(63)	2-bit	KP	
7	(65)	30-bit	Reserved	
[1] – Data for GLONASS is transmitted in the form of 3 consecutive INT32U-type words. During reception, words should be sequentially buffered and then corresponding bit fields should be extracted.				

Note: The parameters of recalculation of time scales data has the same format as the data of transmitted in a navigation signal.

6.5.6 Message 69h – Differential Corrections

This message is used to send differential corrections of GLONASS and GPS satellites to the receiver. The structure of message 69h is shown in Table 69. The size of data in the message is [3 + (13 * number of satellites)] bytes.

Table 69. Structure of 69h message data fields

Parameter No	Offsetting, byte (bit)	Type	Description	Value
1	0	INT8U	Type of Corrections	1 – GPS 2 – GLONASS
2	1	INT16U	Time of Corrections	Seconds within an hour
Further goes N entry for every Satellite of the System				
3	3 + N*13	INT8U	PRN	
4	4 + N*13	INT16U	IOD	
5	6 + N*13	INT16U	UDRE, cm	
6	8 + N*13	FP32	PRC, m	
7	12 + N*13	FP32	RRC, m/s	

6.5.7 Message 6Ah – Reference Location

This message is designed to enter (approximate) reference location information into the receiver. The structure of message 6Ah is represented in Table 70. The size of this message data is 14 bytes.

Table 70. Structure of 6Ah message data fields

Parameter No	Offsetting, byte	Type	Description	Value
1	0	24-bit	Latitude in WGS-84 [1]	B, radians
2	3	24-bit	Longitude in WGS-84 [2]	L, radians
3	6	INT16S	Altitude above Ellipsoid, m	
4	8	INT16U	RMS for latitude, m	
5	10	INT16U	RMS for longitude, m	
6	12	INT16U	RMS for altitude, m	
[1] – Latitude is recalculated into an integer by the following formula: VALUE = B * 2^23 / 90 The integer value is represented as a 24-bit signed number. [2] – Longitude is recalculated into an integer by the following formula: VALUE = L * 2^23 / 360 The integer value is represented as a 24-bit signed number.				

6.5.8 Message 6Bh – Reference Time

This message is used to send the current time to the receiver. The structure of the 6Bh message is shown in Table 71. The size of data in the message is 7 bytes for time flag 1 or 2 (parameter 1) and 10 bytes for time flag 10.

Table 71. Structure of 6Bh message data fields

Parameter No	Offsetting, byte	Type	Description	Value
1	0	INT8U	Time flag	1 – GPS 2 – UTC 10 – Extended UTC
2	1	INT16U	Week Number	Starting of 22.08.1999 modulo 1024
3	3	INT32U	Week Time, ms	0 to 604'800'000
4	7	INT16S	LEAP SECONDS, c	
5	9	INT8U	Root Mean Square Error of the Time Being Set	0 to 6

Compliance of parameter 5 value with the value of the root mean square error of the time is determined by the table:

Parameter 5 Value	0	1	2	3	4	5	6
Root Mean Square Error	0.1 s	1 s	100 s	1000 s	10000 s	60000 s	600000 s

Abbreviations and Legend

GF	Geometric Factor, Dilution of Precision (DOP)
LSB	Least significant bit
MSB	Most significant bit
RRD	Radio Receiving Device
RMS	Root Mean Square Error
CS	Coordinate System
CRC	Cyclic Redundancy Code
COM	RS-232C Bi-directional serial interface
FDE	Failure Detection and Elimination
GDOP	Spatial and Temporal Geometric Factor (Dilution of Precision)
HDOP	Horizontal Geometric Factor (Dilution of Precision)
RAIM	Receiver Autonomous Integrity Monitoring
TTFF	Time to First Fix
VDOP	Vertical Geometric Factor (Dilution of Precision)
UTC	Universal Time Coordinate in relation to the Greenwich meridian
UTC (SU)	Secondary Universal Time Coordinate (UTC) in relation to Moscow Time Zone

Appendix A

A.1 Structures of Types of Data with a Floating Point

A.1.1 Legend

MSB – most significant bit,

LSB – least significant bit,

Denormalized number – a number different from zero, an exponent thereof has a minimum value and the first significant bit has a zero floating-point coefficient.

NaN (not a number) – infeasible value of a number.

A.1.2 Short Precision Number Type

A FP32-type 4-byte (32-bit) number is subdivided into three fields: s – sign bit, e – offset exponent, M – floating point coefficient remainder

1	8		23	
s	e		M	
	MSB	LSB	MSB	LSB

The value of this number is found through the following expressions:

If 0 < e < 255, then $\text{value} = (-1)^s \cdot 2^{e-127} \cdot \left(1+M/2^{23}\right)$;

If e = 0 and f $\neq$ 0, then $\text{value} = (-1)^s \cdot 2^{-126} \cdot \left(M/2^{23}\right)$ (denormalized numbers);

If e = 0 and f = 0, then $\text{value} = (-1)^s \cdot 0$;

If e = 255 and f = 0, then $\text{value} = (-1)^s \infty$;

If e = 255 and f $\neq$ 0, then value = NaN.

A.1.3 Double Accuracy Number Type

A FP64-type 8-byte (64-bit) number is subdivided into three fields:

1	11		52	
s	e		M	
	MSB	LSB	MSB	LSB

The value of this number is found through the following expressions:

If 0 < e < 2047, then $\text{value} = (-1)^s \cdot 2^{e-1023} \cdot \left(1+M/2^{52}\right)$;

If e = 0 and f $\neq$ 0, then $\text{value} = (-1)^s \cdot 2^{-1022} \cdot \left(M/2^{52}\right)$ (denormalized numbers);

If e = 0 and f = 0, then $\text{value} = (-1)^s \cdot 0$;

If e = 2047 and f = 0, then $\text{value} = (-1)^s \infty$;

If e = 2047 and f $\neq$ 0, then value = NaN.

A.1.4 Enhanced Accuracy Number Type

A FP80-type 10-byte (80-bit) number is subdivided into four fields:

1	15		1	63	
s	e		i	M	
	MSB	LSB		MSB	LSB

The value of this number is found through the following expressions:

If 0 < e < 32767, then $value = (-1)^s \cdot 2^{e-16383} \cdot \left(1 + M/2^{63}\right)$;

If e = 0 and f ≠ 0, then $value = (-1)^s \cdot 2^{-16382} \cdot \left(M/2^{63}\right)$ (denormalized numbers);

If e = 0 and f = 0, then $value = (-1)^s \cdot 0$;

If e = 32767 and f = 0, then $value = (-1)^s \infty$;

If e = 32767 and f ≠ 0, then value = NaN.

Field I equals 1 except in cases when all the other bits are zero.

A.2 CRC Calculation Program Using a Bit-by-Bit Method

For a 16-bit CRC calculation the individual bits of a message are consequently combined into a single binary number. Values of the bits of this number are considered as coefficients of the data polynomial. Prior to the division operation, the data polynomial shall be multiplied by x^{16} . This provides the addition of 16 zero bits at the end of polynomial. Then the data polynomial is divided by the generative (seed) polynomial. In practice a binary XOR operation is used instead of division. Addition of 16 bits to data polynomial is necessary in order to make all the bits of the message go through division operation. It is also important to note that, in terms of software implementation, a polynomial is used simply as a 16-bit value 1021h.

Below there is a program in C-code, which calculates all of the CRC values for numbers from 0 to 255 and records them into a file. A table calculated by this program is used in the table algorithm of CRC calculation (see below).

```
#include <stdio.h>
#define CRC_POLY 0x1021
int crc16bit(unsigned char c)
{
  int crc=0;
  int j;
  crc=c;
  crc=crc<<8;
  for(j=0;j<8;j++)
  {
    if (crc&0x8000) crc=(crc<<1)^CRC_POLY;
    else crc=crc<<1;
  }
  return (crc&0xFFFF);
}
int main()
{
  int i;
  FILE *fcrc=fopen("crc.txt","w");
  for(i=0;i<256;i++)
  {
    fprintf(fcrc,"0x%04X,",crc16bit(i));
    if (!((i+1)%11)) fprintf(fcrc,"\n");
  }
  fclose(fcrc);
}
```

A.3. A Program of CRC Calculation Using a Tabular Method

From the point of view of calculating speed, the most effective method is the tabular method. In the tabular algorithm, 8 MSBs of the CS accumulator are combined using a XOR operation with current data byte. As a result, an intermediate value is obtained which is often referred to as combined value. Then CRC is calculated for this combined value (using a table), which is then combined with the LSBs of the accumulator in order to obtain a new CS.

Below there is C-code example which contains an “add_CRC” function to calculate the CS. As parameters the function uses previously calculated CS (CS=0 for first processed byte) and next byte of processed data frame.

```
unsigned short Table_CRC[256]={
  0x0000,0x1021,0x2042,0x3063,0x4084,0x50A5,0x60C6,0x70E7,
  0x8108,0x9129,0xA14A,0xB16B,0xC18C,0xD1AD,0xE1CE,0xF1EF,
  0x1231,0x0210,0x3273,0x2252,0x52B5,0x4294,0x72F7,0x62D6,
  0x9339,0x8318,0xB37B,0xA35A,0xD3BD,0xC39C,0xF3FF,0xE3DE,
  0x2462,0x3443,0x0420,0x1401,0x64E6,0x74C7,0x44A4,0x5485,
  0xA56A,0xB54B,0x8528,0x9509,0xE5EE,0xF5CF,0xC5AC,0xD58D,
  0x3653,0x2672,0x1611,0x0630,0x76D7,0x66F6,0x5695,0x46B4,
  0xB75B,0xA77A,0x9719,0x8738,0xF7DF,0xE7FE,0xD79D,0xC7BC,
  0x48C4,0x58E5,0x6886,0x78A7,0x0840,0x1861,0x2802,0x3823,
  0xC9CC,0xD9ED,0xE98E,0xF9AF,0x8948,0x9969,0xA90A,0xB92B,
  0x5AF5,0x4AD4,0x7AB7,0x6A96,0x1A71,0x0A50,0x3A33,0x2A12,
  0xDBFD,0xCBDC,0xFBBF,0xEB9E,0x9B79,0x8B58,0xBB3B,0xAB1A,
  0x6CA6,0x7C87,0x4CE4,0x5CC5,0x2C22,0x3C03,0x0C60,0x1C41,
  0xEDAE,0xFD8F,0xCDEC,0xDDCD,0xAD2A,0xBD0B,0x8D68,0x9D49,
  0x7E97,0x6EB6,0x5ED5,0x4EF4,0x3E13,0x2E32,0x1E51,0x0E70,
  0xFF9F,0xEFBE,0xDFDD,0xCFFC,0xBF1B,0xAF3A,0x9F59,0x8F78,
  0x9188,0x81A9,0xB1CA,0xA1EB,0xD10C,0xC12D,0xF14E,0xE16F,
  0x1080,0x00A1,0x30C2,0x20E3,0x5004,0x4025,0x7046,0x6067,
  0x83B9,0x9398,0xA3FB,0xB3DA,0xC33D,0xD31C,0xE37F,0xF35E,
  0x02B1,0x1290,0x22F3,0x32D2,0x4235,0x5214,0x6277,0x7256,
  0xB5EA,0xA5CB,0x95A8,0x8589,0xF56E,0xE54F,0xD52C,0xC50D,
  0x34E2,0x24C3,0x14A0,0x0481,0x7466,0x6447,0x5424,0x4405,
  0xA7DB,0xB7FA,0x8799,0x97B8,0xE75F,0xF77E,0xC71D,0xD73C,
  0x26D3,0x36F2,0x0691,0x16B0,0x6657,0x7676,0x4615,0x5634,
  0xD94C,0xC96D,0xF90E,0xE92F,0x99C8,0x89E9,0xB98A,0xA9AB,
  0x5844,0x4865,0x7806,0x6827,0x18C0,0x08E1,0x3882,0x28A3,
  0xCB7D,0xDB5C,0xEB3F,0xFB1E,0x8BF9,0x9BD8,0xABBB,0xBB9A,
  0x4A75,0x5A54,0x6A37,0x7A16,0x0AF1,0x1AD0,0x2AB3,0x3A92,
  0xFD2E,0xED0F,0xDD6C,0xCD4D,0xBDAA,0xAD8B,0x9DE8,0x8DC9,
  0x7C26,0x6C07,0x5C64,0x4C45,0x3CA2,0x2C83,0x1CE0,0x0CC1,
  0xEF1F,0xFF3E,0xCF5D,0xDF7C,0xAF9B,0xBFBA,0x8FD9,0x9FF8,
  0x6E17,0x7E36,0x4E55,0x5E74,0x2E93,0x3EB2,0x0ED1,0x1EF0};
// crc – CS battery value (0 – at the first call)
// c  – data byte
void add_CRC(unsigned short int *crc,unsigned char c)
{
  unsigned short int cval=((*crc>>8)^c)&0xff;
  *crc=(*crc<<8)^Table_CRC[cval];    // new CRC
}
```

A.4 Coordinate Extrapolation Algorithm

Let us designate the user PVT vector at the moment of t0 as $[X,Y,Z,Vx,Vy,Vz]_{t0}$ where:

X, Y, Z are the user's coordinates in the ECEF coordinate system,
Vx, Vy, Vz – the user's speed in the ECEF coordinate system,

The following vector is taken as the extrapolated PVT-vector of the user at the moment of t1:

$$[X,Y,Z,Vx,Vy,Vz]_{t1} = [X,Y,Z,Vx,Vy,Vz]_{t0} + [Vx,Vy,Vz,0,0,0]_{t0} \cdot (t1 - t0).$$

APPENDIX B

B.1 NV08C Default Settings

General Parameters	
Working Satellite Navigation System	GLONASS+GPS+SBAS
The value of a minimum satellite height mask starting from which search and tracking will be performed	5 °
The minimum Signal/Noise Ratio for use in navigation	12
The maximum value of the root mean square error at which calculated coordinates shall be deemed valid	200 meters
Solution Filtration Factor	3
Enabling/Disabling to use satellites for solution of a navigation task	All-in-view
Time Zone	UTC
BINR Protocol Operating Mode	Without CS protection
Operating Parameters:	
Consumer's Maximum Possible Acceleration;	50 m/s^2
Navigation Task Solution Rate	1 Hz
Pseudo Range Smoothing Interval	100 sec
Time Pulse (PPS) control	Programmed, positive polarity, duration 1 ms, adjustment – UTC, always available regardless of whether the Navigation fix is reliable or not
Antenna Cable Temporary Delay	0
Navigation Task Operation Mode	
Priorities of Satellite Systems	At first, GLONASS+GPS shall be captured, and then SBAS.
Mode of Operation with Differential Corrections	RTCM shall be used automatically and SBAS upon request.
Mode of Operation with Atmospheric Corrections	used automatically
Current Status of the Receiver Channels	Automatic search and tracking

These settings are effective to FW v02.05 and may vary for different FW version.