Analysis of noise immunity of GLONASS and GPS positioning receivers

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Abstract. The article describes the method of comparative analysis of noise immunity of GLONASS and GPS satellite positioning receivers based on a broadband noise oscillator which allows us to compare multivendor positioning receivers on a real-time basis. Besides, the suggested method enables to assess the capacity of a robust positioning signal produced by GLONASS and GPS systems to resist the noise. The method is characterized by the clarity of obtained results and allows to choose products of the best quality among the commercially available models of positioning receivers.

1. Introduction

Applicability of modern GLONASS and GPS positioning equipment is growing significantly in commercial enterprises and also the Armed Forces of the Russian Federation. Transport enterprises use positioning receivers to track location of their means of transport on a real-time basis [1]. This allows them to control the traffic route of their transport, its average and current speed, fuel consumption, etc.

The use of positioning receivers in the toll system Platon allows the owners of transport enterprises to enhance control over the distance covered by trucks on federal roads and, consequently, pay only real kilometre without overpay [2].

Nowadays the market offers a large number of positioning receivers which can function either with a certain positioning system – single system receivers, or multifunctional receivers which can simultaneously process signals from several systems. The most widely used systems are Russian made system GLONASS and US system GPS. As a rule, receivers are different in their usability and price, however, among this large variety of products an amateur in wireless communication experiences difficulty in choosing a positioning receiver which efficiently functions in complex electromagnetic environment which is common of large cities where there are many neighboring telecommunications providers and industrial facilities which signal transmitters and other electronic devices are the source of unintended interference influencing the functioning of positioning receivers.

From this perspective, the aim of the current paper which is to assess the capability of GLONASS and GPS positioning receivers to resist unintended interference becomes more and more important.

2. Statement of the problem

At present Russian and foreign industrial companies produce a large number of positioning receivers of different technical performance: as separate devices or as units, and also in the form of a navigation module incorporated into other multifunctional devices.
As a rule performance specifications written in manuals to positioning receivers include the type of used positioning systems (GLONASS, GPS, BEIDOU, etc.), sensitivity, selectivity, weight-size parameters, electric power consumption and an interface type of output positioning parameters [3-4].

At the same time, when one needs to choose this or that device a consumer pays attention to usability of positioning receivers and the type of navigational software. However, at present, as a result of increase in the number of telecommunication devices and electromechanisms in our surrounding environment the most important characteristic of any receiver is its ability to resist intended or unintended interference.

For lines of multichannel communication which provides wireless transmission of information in the form of a radio signal the issue of electromagnetic compatibility assessment of different radioelectronic devices is a vital one and is monitored by radio agencies.

Traditional approach to assessment of electromagnetic compatibility of radioelectronic devices is based on assessment of signal-to-noise level at the reception point and assessment of tolerable noise level which allows providing a set amount of communication [5,6] cannot be used to satellite navigation in their traditional form because they are aimed at stationary operation of electronic devices contrary to navigational systems in which a positioning receiver is constantly in space and time, and movement of navigational satellites is a basic cause of signal level changes at the input of positioning receivers.

In that context, to estimate the noise immunity of positioning receivers produced by different vendors we have developed a method which allows us to compare functioning capacities of several positioning receivers simultaneously on a real-time basis and judging by their functioning in case of interference choose the best receiver out of the considered ones.

3. Method of solution and simulation results

In order to solve the problem of noise immunity assessment of positioning receivers we have developed a test bench (figure 1) including a noise generator, spectrum analyzer Instek GSP-7830 made by Good Will Instruments Co. Ltd., and two positioning receivers: module BU-373GLONASS (BU-373G) made by Globalsat Technology Corporation and multifunctional navigational module NL 5500 BYFVR made by Nokia [4].

The noise generator has been developed and produced by ourselves as a part of the carried out scientific experiment. As a basis we have used a noise generator for mobile communication systems with 1800/1900 Mhz frequency interval based on an self-excited oscillator with regenerative feedback in transistor basic circuit. By measuring inductive properties and self-excited oscillator capacities the center frequency of interference became equal to 1575 MHz that corresponds to L1 band of GLONASS and GPS systems.

![Figure 1. The measurement bench](#)
Absence of high-quality resonators in the system allowed increasing the bandwidth of generated oscillations to 40 MHz, and application of a pot resistor to the control power circuit allowed to gradually change power output from 0W to 1W.

Depiction of results of BU-373G functioning was done by means of GPSInfo.exe software supplied complete with the receiver. The results of NL 5500 BYFVR were registered by Navitel, ver. 9.6.2385.

InstekGSP-7830 spectrum analyzer monitored power level and bandwidth of interference produced by the noise generator.

Positioning receivers were located at the same distance from the noise generator in a place which provided consistent signal reception of positioning systems. When receivers were switched on and collected operational and non-operational data necessary for functioning from navigational satellites, we switched them over to stationary operation conditions which provided consistent signal reception from navigational satellites and determined the consumption vector (figure 2 a, 2 b). The level of natural unintended interference in the place of reception was about -35 dBmW that did not prevent positioning receivers from reception of navigational signal from nearly 16 earth satellite vehicles.

Further on, using pot resistor in the noise generator we changed its output power of the produced broadband interference from minimal to maximum.

When the noise power was increased the number of navigational satellite vehicles detected by positioning receivers started to reduce. (figure 3 a, 3 b).

When the level of interference reached nearly 100 megawatts, BU-373G stopped getting the signal from earth satellite vehicles, and NL 5500 BYFVR received signal from only 5 earth satellite vehicles determining consumption vector from only two of them (figure 4 a, 4 b).

![Image](image1.png)

**Figure 2.** Functioning of NL 5500 BYFVR (a) and BU-373G (b) when there is no interference.

![Image](image2.png)

**Figure 3.** Functioning of NL 5500 BYFVR (a) and BU-373G (b) in case of low interference.
4. Results

With further increase in the level of interference up to the maximum both positioning receivers stopped detecting valid signal from signal-to-interference mixture at the input (figure 5).

Therefore, the conducted experiment was aimed at assessment of positioning receivers' capability to function in conditions when strong broadband interference was influencing their radio link. As a matter of practice we compared two positioning receivers which showed different resistance to interference.

Positioning receiver NL 5500 BYFVR detected more navigational satellites in comparison to BU-373G, and also received and processed navigational signal more efficiently. When there was no interference NL 5500 BYFVR received signals from a larger number of GLONASS navigational satellites than GPS navigational satellites, however, when the interference power increased, GPS radio signal proved to be more noise-resistant.

Figure 4. Functioning of NL 5500 BYFVR (a) and BU-373G (b).

Figure 5. Functioning of NL 5500 BYFVR (a) and BU-373G (b) in case of maximum interference.

Real-life electromagnetic environment could become similar to electromagnetic environment created during the experiment if transport would become equipped with a larger number of devices producing electromagnetic field like broadcasting stations, different radar detection devices, road fare transponders, mobile communication devices, etc., and also because of an increase in the number of telecommunication equipment and devices around us.

Openness of the developed method leaves an opportunity for its adoption in relation to different interference environment and for the increase in the number of positioning receivers under consideration, etc.
5. Conclusions
The developed noise generator allows making a comparison of different GLONASS and GPS positioning receivers on a real-time basis. The given design of the experiment is simple and efficient. It can be used in transport companies and enterprises that will help to conclude about advisability of purchasing of positioning receivers of different vendors without complicated assessment of electromagnetic environment, and also will give an opportunity to estimate efficiency of different navigational systems.

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