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INTERFERENCE PROTECTION METHODS IN RADIO-ELECTRONIC MEANS

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Annotation

In the case of broadband or spatially changing narrow-band interference, it is necessary to use transversal filters based, for example, on an adjustable multi-tap delay line [5]. A relatively narrow-band amplitude-phase regulator with quadrature splitting of signals is installed in each tap of the delay line. The efficiency of PDSS when using transversal filters with three and five taps, as shown in the work, is almost the same, and for a relative signal frequency band of up to 40%, transversal filters with three taps are sufficient.

Keywords: megacities, mutual interference, frequency resource, radio frequency anarchy,

Introduction

Satellite communication is the development of traditional radio relay communication by placing the repeater at a very high altitude. Since the maximum area of its visibility, in this case, is almost half of the globe, there is no need for a chain of repeaters - in most cases one is enough.

Main Part

In the most general form, based on the principles of implementation, it is possible to distinguish organizational, energy, signal, and spatial methods of protection against radio interference.

The organizational method in a simple version assumes such an arrangement of radio signal sources and such a choice of frequencies at which the electronic means of the designed systems will not create mutual interference. It is obvious that at present this method of frequency-territorial separation in the conditions of megacities and industrialized regions, saturated with radio-electronic means, is not becoming very effective. However, it has been approved and is being used in a form that requires the implementation of mandatory procedures for mutual coordination and registration of radio frequency bands of various networks defined by international and national regulations. During the implementation of these coordination procedures, operators must agree on mutually acceptable signal-to-interference ratios and thereby achieve the required level of electromagnetic compatibility. For this purpose, the polarization decoupling method is widely used. If necessary, the method of frequency segmentation is used, which limits the frequency resource used, but operators are forced to do this to achieve coordination agreements on mutually acceptable terms.

20–30 years ago, it seemed that strict implementation of regulatory procedures and compliance with agreements would ensure, with a high degree of probability, the operation of communication systems without mutual unacceptable interference. However, at present, well-known Russian specialists in radio frequency support believe that a crisis is coming in satellite communications, connected precisely with the very system of distribution of the radio frequency resource. Many satellite operators recognize that modern satellite communications networks, which have passed all the stages of coordination and registration, nevertheless experience an increasing level of unacceptable interference. This means that the organizational method of protection against interference, based on the current regulatory procedures, has largely exhausted itself and cannot be recognized as sufficiently effective. Despite this, this method of frequency allocation, based on international and national regulations, is the main tool for radio frequency regulation and containment of "radio frequency anarchy".

Thanks to the rapid development of digital technology in the last 20 years, it has become possible to put into practice signal interference protection methods based on digital signal processing and allow to reduce the impact of interference at a level of 20 ... 30 dB. This is, first of all, the use of pseudo-random, multi-frequency, and broadband noise-like signals, as well as methods of error-correcting signal coding. They are widely used in modern satellite communication systems and demonstrate satisfactory performance. The main disadvantage of these methods is the need to expand (in some cases very significant) the radio frequency spectrum to protect from radio interference. Given the natural limitation of the radio frequency resource, this is a significant drawback that reduces the effectiveness of such methods, especially in high-speed systems. It is known that the use of signal methods leads to a decrease in the noise protection coefficient in proportion to the increase in the speed of information flow. Despite these shortcomings, signal methods remain very effective, and are constantly being improved, and it should be expected that they will be in demand in the future, especially in combination with some methods of spatial noise protection.

The latter has been developed and used for more than a dozen years. The simplest of them is the shielding of radio-electronic equipment in the direction of interference and the use of radio-absorbing coatings in certain areas of the antenna mirror to reduce the effect of receiving interference from the side lobes of the antenna system. These types of methods have taken their place, but are not widely used since they are not always able to provide the necessary level of protection against radio interference. For example, shielding does not provide reliable noise protection in the event of random interference from an indefinite direction, and at the same time, it involves the creation of rather bulky structures. Radio-absorbing coatings have limitations on the level of interference reduction, which is far from always sufficient.

The method of electronic interference compensation, or spatial interference rejection (the most difficult in terms of technical implementation), is based on reproducing a copy of the interfering signal to be suppressed. Note that the noise protection coefficient of this method, in contrast to the signal method, practically does not depend on the information transfer rate. Its effectiveness depends on the accuracy of the reproduction of a copy of the interference signal and, according to some estimates, it can reach an interference suppression level of up to 40 dB. Such a result is quite possible to obtain in the laboratory. In practice, in a spatial interference rejection system operating under real conditions of interference from 2–3 directions, a level of 20–25 dB has already been reached today. Improvement of the electronic component base, as well as the use of a fundamentally new mathematical apparatus and functional software based on it, will significantly improve the results obtained.

Conclusions

The energy method of dealing with interference provides for an increase in the transmitter power to a level that is guaranteed to exceed possible interference. It is quite widely used in special and military satellite communication systems, but its use is in conflict with the need to ensure electromagnetic compatibility, and regulatory restrictions, and, in addition, is energy-consuming and noise-immune.

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