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ALGORITHM FOR DETERMINATION OF ELECTROMAGNETIC COMPATIBILITY FOR SOLUTION OF FREQUENCY PLANNING PROBLEMS

The intensive development of the telecommunications sector is directly connected with the introduction of the latest radio technologies and communication systems, the emergence of new services and communications. In these conditions, the provision of the requirements for the radio frequency resource of all categories of users is carried out at the expense of redistribution of already mastered and further development of new frequency ranges. Redistribution of frequencies, in turn, leads to an increase in supply on already developed ranges, which is due to the growth of the number of existing radio electronic devices, and to the complication of electromagnetic environment. The development of new ranges dictates the need to allocate radio frequency bands for the latest radio technologies, systems and communication standards. In these conditions, the task of controlling the PCR and ensuring the electromagnetic compatibility of radio electronic devices and emitters are of great practical importance.

These tasks can be solved only with the implementation of the appropriate scientific and methodical apparatus of radio monitoring, the application of which would enable the efficient use of radio frequency resource in modern conditions. Therefore, the topic of the thesis is relevant.

The paper presents the reasons for the occurrence of interference in the work of radio electronic devices in a complicated electronic environment, examines the modern scientific and methodical apparatus of radio monitoring with the definition of the electromagnetic environment at this location for the solution of frequency scheduling of RES.

INTRODUCTION

In this paper an analysis of the causes of mutual interference with the work of radio-electronic means in a complicated electronic environment is conducted, the modern scientific-methodical apparatus of radio monitoring with the definition of electromagnetic environment in it for solving the problems of frequency scheduling of the RES of the mobile service is considered.

The object of research – the process of determining the electromagnetic environment for the solution of the problems of frequency planning of radio electronic vehicles of the mobile service.

Subject of research – research and calculation of EMC REF in the planning area.

The purpose of the work is to study the effectiveness of using and defining directions for improving the calculation of EMC REFs in the planning area.

The method involves the analysis of EMC REZ in the planning area, and in the case of using the general site for the disposal of RES-EMC local grouping of RES (object EMC).

In the first case, the following types of interference are taken into account[1]:

– on the main channel;
– on the first adjacent channel;
– intermodulation obstruction of the 3rd order.
– In the second case, in addition to those listed above, the following types of interference are taken into account [2]:
– on adjacent channels;
– intermodulation above 3rd order (up to 13th order inclusive);
– blocking;
– on the mirror channel;
– on the first IF;
– on harmonics.

In carrying out the analysis, the above-mentioned methodology, an indicator of the efficiency of this method was established, with lower costs for measurements of the electromagnetic environment, and recommended for widespread use of this technique, with the control and management of the radio frequency resource and the provision of electromagnetic compatibility of radio-electronic means.

Keywords: source of radio emission, electromagnetic environment, electro-magnetic compatibility, point of technical radio control, radio-emitting device, radio regulation, radio technology, radio frequency resource.

MAIN PART

The intensive development of the telecommunications sector is directly linked with the introduction of new radio technologies and communication systems, the emergence of new services and communications. In these conditions, the provision of the requirements for the radio frequency resource of all categories of users is carried out at the expense of redistribution of already mastered and further development of the new frequency range.

Redistribution of frequencies, in turn, leads to an increase transferring to the already developed ranges of radio frequencies, which is due to the increase in the number of existing REFs, and to the complication of electromagnetic environment. The development of new frequency bands dictates the need to allocate radio frequency bands for new radio technologies, systems and communication standards. Under these conditions, the control of PCD and the provision of electromagnetic compatibility (EMC) of REFs and radiating devices (VPs) are of great practical importance.

At the same time, in recent years, developers and manufacturers of telecommunication facilities have paid considerable attention to higher ranges of radio frequencies, which are considered the most promising for practical development. Currently, in Ukraine, the 3.5 GHz radio frequency range is intensively deployed

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by WiMAX radio technologies, 6/4 GHz, 8/7 GHz, 14/11 GHz and 30/20 GHz radio frequencies are saturated with satellite communication systems.

The complexity of solving the problems of radio monitoring in the frequency bands over 3 GHz is due to:

- difficulties in detecting, detecting the location of DRV and measuring the parameters of their radio emission;
- differences in the legislative regulation of the use of HRD in Ukraine from a number of European countries;
- lack of necessary technical equipment and appropriate regulatory and methodological support for radio monitoring.

In spite of the large variety of radio services, radio technologies, systems and communication standards that exist today in the world, in practice, for the purpose of solving radio monitoring problems, a limited number of methods can be used. This is the position of radio technology on the possibility of combining radio technology and communication systems into groups according to certain criteria, which will promote the application of common methods for detecting radiofrequencies, measuring their parameters, positioning and location of DRV, etc. It remains only to determine the criteria for such a classification, to distribute radio communication systems to groups according to these criteria, to note for each of the groups its own methods of radio monitoring and a list of technical parameters that need to be measured and (or) determined during its conduct. In practice, talking about radio monitoring, often mean a few other concepts, in particular, control of parameters of radio signals in high-frequency tracts.

The technical characteristics of RES are [3]:

- transmitter power;
- transmission frequency;
- frequency of reception;
- spectrum (frequency mask) of the transmitter signal;
- radiation class;
- azimuth of maximum antenna radiation;
- Antenna gain, type and polarization of the antenna;
- Antenna direction diagram;
- height of the antenna hinge;
- the value of the required protective ratio;
- reliable communication is required in the absence of interference.

The technical characteristics of the REF, which is planned, can be obtained from the materials of the RF application submitted by the applicant, and the REFs participating in EMC calculations in the planning area from the general database of frequency assignments

The basis of the procedure for selecting the frequency for the RES is the analysis of the EMC RES, which consists in the calculation of EMC in the area of planning and EMC local grouping of RES (object EMC).

The calculation of the EMF REF in the planning area is carried out in the following order:

a) the choice of territorial characteristics of RESs, located in the area of a limited research area;

b) selection of RES that are selected on a territorial basis, on the frequency basis of those REFs that potentially interfere with the new frequency assignment:

– identification of possible sources of noise over the main channel;
– determining the sources of interference on the first adjacent channel;
– identification of possible sources of intermodulation noise in the 3rd order.

c) calculation of the level of noise at the receiver input:

– on the main channel;
– on the first adjacent channel;
– intermodulation of the 3rd order;

d) analysis of the results obtained and decision making based on the results of calculations on the possibility of frequency assignment, taking into account the effect of multiple noise or the need to select a different frequency. In the case of a positive decision on the possibility of frequency assignment based on the results of calculating the EMC, it is necessary to check the presence of other RES on the joint site and, if available such, to calculate EMC local grouping of RES (object EMC).

EMC local grouping of RES is performed in the following order:

a) among RES, selected according to the preceding paragraph are selected RES, which are located within a common area in a circle with a radius of up to 1 km from the BS, under investigation. The radius of 1 km is due to the following assumption: the losses during the propagation of radio waves for this distance are 60 ÷ 100 dB (model of distribution in free space), depending on the frequency range, which minimizes the probability of the receiver effecting other types of disturbances at long distances from the transmitter to a minimum. All stations that fall into a zone limited by this circle are selected for further analysis.

b) RES, which potentially can cause interference with the receiving BS or is subject to its interference, are selected on a frequency basis among the RES, selected on a territorial basis. For each selected transmitter (or group of transmitters), the frequency condition for the possibility of creating an obstacle for the studied receiver is checked, or for each selected receiver in the selected transmitter group, the frequency condition for interference from the researcher transmitter is checked for the following types of interference:

- by adjacent channels;
- on the intermodulation of the 3rd - 13th orders;
- on the mirror channel;
- on the first IF;
- on harmonics;
- by blocking;

c) levels are calculated for each type of interference;

d) an analysis of the results is carried out and, based on the results of calcula-

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tions, a decision is made on the possibility of frequency assignment taking into account the effect of multiple noise or the need to select a different frequency.

General algorithm of frequency assignment for RES is shown on img. 1

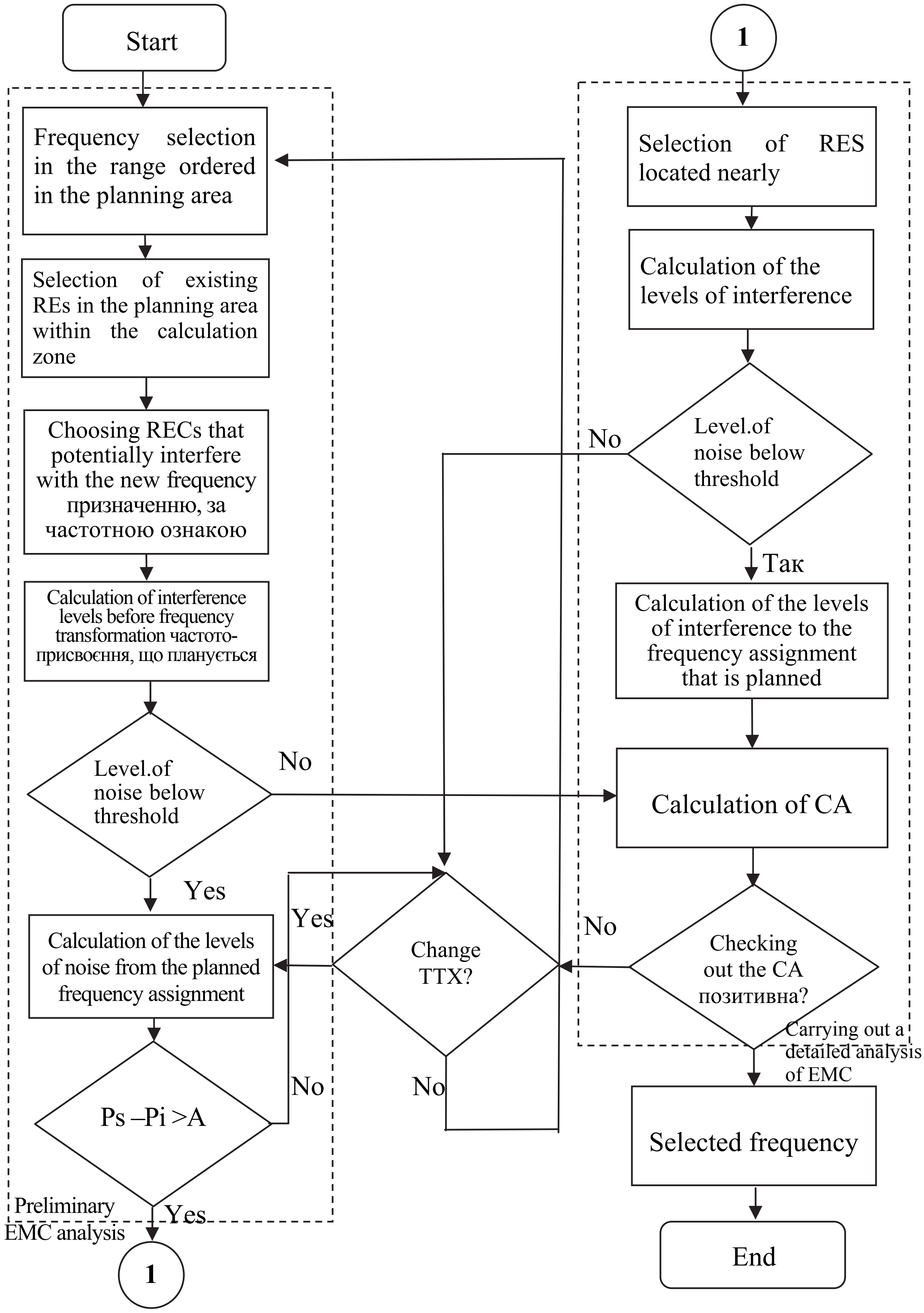

Image. 1 General algorithm of selection of frequencies for RES

To select the stations that characterize the electromagnetic environment at the site of the alleged new frequency assignment, it is necessary to determine the size of the calculated zone. To do this, it is necessary to define a circle with a center at the coordinate of the new frequency assignment (BS) and a radius equal to the double radius of the declared service area (2d) [4] or the corresponding distance according to the standard for this type of communication; and frequency range (img.2)

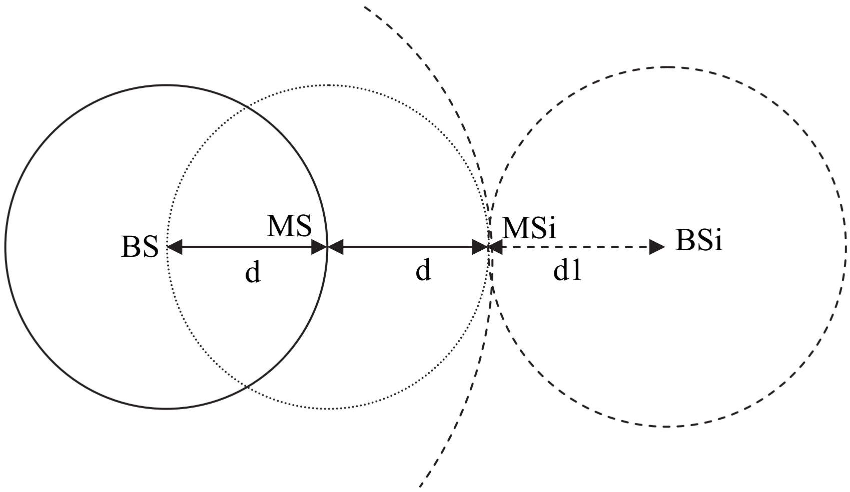

Image.2 Selection of a non-hazardous RES

All stations that fall into space are limited to this circle (moving, together with their base, even if the latter are not in this area), are selected for further analysis to meet the frequency requirements.

Despite the wide variety of factors that influence the quality of signal reception, the classical approach to determining the quality of RES operation is to evaluate the energy ratio of the signal / (noise / noise) with given parameters. Therefore, for the main criterion for evaluating the parameters of the EMC REC, the energy criterion expressed in terms of the signal / noise ratio for the given quality indices is adopted:

$$\frac{P_S}{P_I} \geq A(\Delta f) = A_0 * FDR(\Delta f), \qquad (1)$$

where $A(\Delta f)$ - protective attitude in this frequency decomposition between a useful signal and a barrier;

A_0 - protective relation on the connected channel;

$FDR(\Delta f)$ - a coefficient that characterizes the attenuation of the noise, depending on the frequency deployment between the useful signal and the interference;

P_S - the power of a useful signal at the input of the receiver, subject to interference;

P_I - power interference at the input of the receiver, subject to interference.

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The influence of the medium on the propagation of radio waves, due to the random nature of innumerable causes, is manifested in the change in the amplitude of the wave field, the change in the velocity and direction of propagation of the wave, in the rotation of the plane of polarization of the wave, and other distortions of the signal. Therefore, the fluctuations of the useful signal levels at the input of the receiver are also random variables.

The mobile communication is characterized by large changes in the field strength, as a function of location and time. These changes can be described by the lognormal distribution with a standard deviation of 8 dB in the range of 30-300 MHz and 10 dB in the range of 300-3000 MHz [5].

The specific value of the value of the required protective ratio is the characteristic of the studied system of mobile communication (mobile communication standard) and is given as an initial data in the analysis of the EMC.

CONCLUSION

The reasons of the occurrence of mutual obstacles in the work of radio-electronic means in the complicated electronic environment are described, the modern scientific-methodical apparatus of radio monitoring with the definition of electromagnetic environment in it for solving the problems of frequency scheduling of the RES of the mobile service is considered.

The method involves the analysis of EMC REZ in the planning area, and in the case of using the general site for the disposal of RES-EMC local grouping of RES (object EMC).

In the first case, the following types of interference are taken into account:

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In the second case, in addition to those listed above, the following types of interference are taken into account:

– on adjacent channels;
– intermodulation above 3rd order (up to 13th order inclusive);
– blocking;
– on the mirror channel;
– on the first IF;
– on harmonics.

In carrying out the analysis of the aforementioned methodology, an indicator of the efficiency of this method was established, with lower costs for measurements of the electromagnetic environment, and recommended for widespread use of this technique, with the control and management of the radio frequency resource and the provision of electromagnetic compatibility of radio-electronic means.

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