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**NATURAL-LIKE TECHNOLOGIES OF PROTECTION  
OF RADIO-ELECTRONIC EQUIPMENT FROM THE IMPACT  
OF POWERFUL ELECTROMAGNETIC RADIATIONS**

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Development, creation and use of generators with a radiation power of the order of and more than 1 GW with pulse duration of  $10^{-9}$  to  $10^{-15}$  seconds necessitates the further development of methods and devices for the protection of radio electronic means. This is due to the possibility of both accidental and deliberate (as a result of terrorist acts) use of such generators, which can lead to the REM disruption at considerable distances. At the same time, the threat of REM serviceability disruption is usually created when electromagnetic radiation (EMR) interacts with antennas, communication lines, conductors and radioelements of equipment. This interaction

leads to the transformation of the electromagnetic field into voltages and currents.

The most vulnerable to the EMR influence are the REM elements directly connected to the antenna output, to the cables and conductors. In addition to these elements, the cables themselves are exposed to impulse voltages, which in certain cases can damage their insulation and cause a short circuit between its cores and the sheath. The most dangerous in terms of its impact on radio electronic equipment (REE) is a powerful EMR of the ultrashort pulse duration (UPD) [1-6].

Proceeding from this, the problem of ensuring the durability and reliability of modern REM to the impact of powerful EMR of ultrashort pulse duration acquires a pronounced systemic character.

REE features, as a protection object, determine the requirements for the applied protective devices, which must:

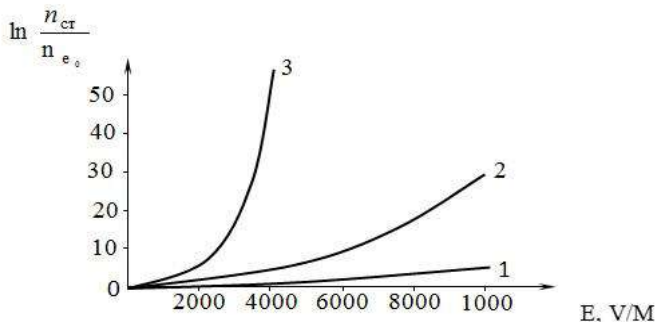
- have high speed;
- not influence the characteristics of the protected radio facilities;
- have stability of characteristics in a wide range of temperatures under the action of damaging EMR factors;
- have ability to quickly restore its electrical strength in conditions of multiple exposure to EMR;
- have overall dimensions and weight smaller than the overall dimensions and mass of the protected equipment.

An analysis of the capabilities of the methods and means of protection developed to date has shown that they do not fully meet the requirements for the REM protection.

Thus, despite a wide range of ongoing research in the development of effective methods and the creation of means for REM protection from the impact of a powerful EMR, there is no protection technology. In turn, the protection technology should provide a unified methodological position for solving the problem of reducing the level of electromagnetic field intensity affecting the REM. The solution of the existing problem is proposed on the basis of the complex application of plasma protection technologies using gaseous and modified solid-state media.

The aim of the work: assessment of the possibility of using plasma media for complex REM protection from the impact of a powerful pulsed EMR.

1. The case of a gaseous plasma medium. The dependence of the logarithm of the ratio of electron densities to the pulse amplitude for different pulse durations, obtained using (1), is shown in Fig. 1

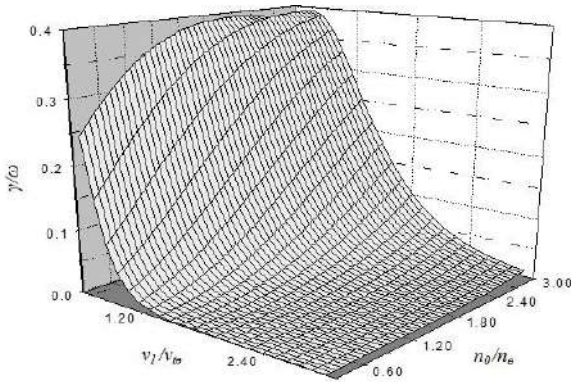


**Fig. 1. Dependence of the logarithm of the ratio of the electron density to the electric field strength for times: 1 – 0.01; 2 – 0.1; 3 – 1 in fractions of the pulse duration  $\tau_p = 3$  ns**

It is established that the breakdown intensity of the electric field depends on the initial concentration of electrons in the discharge volume and the EMR duration. When the ratio of the critical concentration to the initial concentration is changed only by a factor of 5 and the air pressure is 750 mm Hg, the breakdown strength of the field decreases from 30 kV/m to 20 kV/m. With an increase in the pulse duration by an order of magnitude, the breakdown field strength is reduced by a factor of 5  $\lg n_{cr}/n_{e0} = 20$ . As the EMR duration is increased by a factor of 10, the breakdown strength of the electric field decreases by a factor of 3.

2. The case of a solid-state plasma medium. The dependence of the EMR damping  $\gamma/\omega$  on the non-equilibrium parameter is shown in Fig. 2.

In accordance with (3) for the intensity of the radioisotope source of  $70 \mu\text{Cu}/\text{cm}^2$ , due to the non-equilibrium properties of solid-state plasma, the EMR damping coefficient can reach values of the order of 70 dB.



**Fig. 2. Dependence of EMR damping on the non-equilibrium parameter of solid-state plasma**

1. The performed theoretical evaluations testify to the principle possibility of using the proposed technologies for creation of means for REM protection from the EMR influence. The choice of the required initial electron concentration in the gaseous plasma leads to a decrease in the breakdown field strength. Consequently, when creating the necessary initial electron concentration inside the waveguide or between the walls of the case and the cable braiding, a real possibility of REM protection from the impact of powerful EMR appears.

2. The use of a solid-state plasma medium as a shielding material by selecting the intensity of the radioisotope source, as well as the number of layers of the dielectric matrix, allows controlling the absorbing properties of the material. The promising nature of the proposed technology lies in the possibility of its integrated use to protect against possible penetration channels, with limitations on the weight dimensions of protection devices.

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**RECOMMENDATIONS FOR SUBSTANTIATION  
OF REQUIREMENTS FOR CONSTRUCTION OF PROTECTION  
OF RADIOELECTRONIC MEANS FROM THE INFLUENCE  
OF POWERFUL ELECTROMAGNETIC RADIATION**

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