UDC 621.3 **doi:** https://doi.org/10.20998/2522-9052.2023.1.06

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THE INFLUENCE OF A POTENTIAL BARRIER ON THE MECHANISMS OF EXCITATION OF OWN FLUCTUATIONS IN RADIO PRODUCTS IN CONDITIONS OF EXPOSURE TO ELECTROMAGNETIC RADIATION

Abstract. The **subject matter** is the processes of analysis and the mechanisms of the emergence of their own fluctuations in the semiconductor complex electro -radio devices (communications equipment), if there are currents and voltages entrusted with pulsed electromagnetic radiation, the results obtained in the work of the potential barrier on the border of the semi -conductive structure on the border of the semiconductor (voltage ampere) characteristics of a electro -radio device. The **aim** is model of transforming the energy of the flow of charged particles, induced by external electromagnetic radiation, into the energy of its own fluctuations in the semiconductor structure, taking into account the properties of the structure itself (heterogeneity of potential at the border). The implementation of this model is due to the effect of transitional radiation of moving charges, when the particle flow crosses the boundary of the media section with various electromagnetic properties (dielectric permeability) and part of its energy is transformed into the energy of its own fluctuations in the semiconductor structure. The **objectives** are: mechanisms of the strengthening (instability) mode of semiconductor components of semiconductor devices under conditions of impulse electromagnetic radiation in the presence of a potential barrier on the boundary of the media of the media. The **methods** used are the method of theory of small disturbances, which allows you to determine the spectrum of the own vibrations of the system: the current fluctuations of the semiconductor device in electromagnetic radiation. The **following results** are obtained: The interaction of surface plasmons with the flow was considered charged particles in the presence of a potential barrier based on energy principle. Kinetic equations have been obtained that determine the change in the number superficial plasmons, expressions for the increments of their instability with taking into account the size of a potential barrier on the border, which leads to the appearance of a beam reflected from the border. The results of the work allow you to take into account the contribution of the reflected and completed component of the energy flow energy into the total energy of the radiation of surface vibrations. The mechanisms of interaction between the flow of charged particles with the own electromagnetic fluctuations of two -dimensional electronic gas, the occurrence of which is due to the presence of a potential barrier on the border of the media section. **Conclusion**. Determination of the amplification (generation) modes of electro -radio products that distort their volt are ampere characteristics (reversible failures) depending on the parameters of external electromagnetic radiation. An analysis of the routes obtained in the work can be used in the development of radio emergency for working in a millimeter and submilimeter range (amplifiers, generators and frequency converters). Assessment of indicators of the exponential growth of amplitudes of the own fluctuations of semiconductor components (increement of instability as a criterion of reversible failures) show that the magnitude of the energy of radiation lies within the sensitivity of modern receivers of the radiation of the submilimeter range and is the reason for the failure.

Keywords: induced current; electromagnetic radiation; semiconductor components; superficial vibrations; instability of oscillations.

Introduction

An increase in the dependence of the operating capacity of components on the influence of external factors (in particular electromagnetic radiation) is associated with the expansion of areas of application and increasing complexity of tasks, the implementation of which is assigned to the electro -radio production, which leads to an increase in their sensitivity [1]. The most sensitive to the influence of external electromagnetic fields are semiconductor devices (SMD) and integrated microcircuits (IM). The failures of these products are usually associated with electric (the value and distribution of currents in the structure of the devices) and thermal (increasing the temperature of individual sections of the structure) [2]. Therefore, there are a significant impact on the performance of such a rode of electro-radio products, stresses in external radiation have.

In particular, one of the reasons for the appearance of equipment failures is associated with a change in the volt-ampere characteristics of semiconductor devices-the appearance in areas of direct current of areas with negative resistance. The appearance of such sites is associated with the establishment of the regime of strengthening the own fluctuations in the semiconductor structure - the possibility of transforming the energy of the flow of charged particles, induced by external electromagnetic radiation, into the energy of its own fluctuations in the semiconductor structure. The amplification mode is characterized by exponential growth in the amplitude of oscillations i.e. their instability [3, 4]

In this work, the beam instability of the system of charged particles was studied - a semiconductor structure, taking into account the influence of a potential barrier on the mechanisms of their development.

When considering the interaction of electromagnetic oscillations (surface plasmons) and the flow of electrons induced by the external EMI in the work, in addition to the probabilistic approach (kinetic equations), a technique that allows you to establish a relationship between the wave functions of electrons on the border and electromagnetic fields of surface vibrations.

It involves the use of additional (compared to electrodynamic) boundary conditions for indignant wave functions of the beam electrons. At the same time, the phases and amplitudes of the indignant wave functions of the electron are determined by the existing phase and amplitude of the plasmon, so that the interaction of waves and electrons of the bundle is determined. The influence of the border (in particular the presence of a potential barrier) on the amount of the increment of instability is determined by the conditions for wave functions.

In the work, expressions were obtained for the increments of the instability of surface plasmons, taking into account the size of the potential barrier at the border, which leads to the appearance of the beam reflected from the border. The results allow you to take into account the contribution of the reflected and past component of the current of the current in the total energy of the radiation of surface vibrations.

Task solution

Let us consider the interaction of surface plasmons with a stream of charged particles induced by an external EMI in the presence of a potential barrier, based on the energy principle [5].

Let the interface between the media of the semiconductor structure, the component of the electro - radio production, be crossed by a quasi-neutral flow of charged particles (electrons) moving along the axis from the medium “1” (y≤0) to medium (y>0). The potential barrier at the interface has the form:

$$\begin{aligned} &U(y) = 0; -\infty < y < 0; \\ &U(y) = U_0; 0 \le y < \infty. \end{aligned} \qquad (1)$$

Beam particles are characterized by wave functions for the incident – Ψ_1, transmitted – Ψ_2 and reflected - Ψ_3 and are solutions of the Schrödinger equations in each of the media and are written as follows:

$$\begin{aligned} &\Psi_{k_1}^{(1)} = \frac{1}{\sqrt{V}} \exp i(\overrightarrow{k_1 r} - \omega_{k1} t); \\ &\Psi_{k_2}^{(2)} = \frac{\alpha_{k_2}}{\sqrt{V}} \exp i(\overrightarrow{k_2 r} - \omega_{k1}); \\ &\ldots \\ &\Psi_{k_3}^{(3)} = \frac{\beta_{k_2}}{\sqrt{V}} \exp i(\overrightarrow{k_3 r} - \omega_{k1}); \end{aligned} \qquad (2)$$

$$k_{1y} = \left(\frac{2mE_{k1}}{h^2} - k_{1x}^2 - k_{1z}^2 \right)^{1/2};$$

$$k_{2y} = \left(k_{1y}^2 - \frac{2mU_0}{h^2} \right)^{1/2};$$

$$k_{3y} = -k_{1y}; \quad k_{3x} = k_{1x} = k_{3x}; \quad k_{1z} = k_{3z} = k_{1z};$$

$E_{k_1} = h\omega_{k1}; \overrightarrow{k_{1,2,3}}$ – the energy and wave vectors of the incident, transmitted and reflected particles, V is the volume of the system, respectively. The transmission and reflection coefficients for the wave functions are determined from the boundary conditions for the wave functions and their derivatives at the boundary [6]:

$$\alpha_{k2} = \frac{2k_{1y}}{k_{1y} + k_{2y}}; \qquad \beta_{k3} = \frac{k_{3y} + k_{2y}}{k_{3y} - k_{2y}}. \qquad (3)$$

The densities of the number of particles and currents in the beam are, respectively,

$$\vec{j}_{y1} + \vec{j}_{y2} = \vec{j}_{y3}.$$

If the beam of particles incident on the boundary has a speed

$$v_{01} = (0, v_{01}, 0) \quad v_{01} = \frac{hk_{01}}{m};$$

then we get the following relations

$$\begin{aligned} &n_1 = n_2; \quad n_2 = \alpha_{k_0}^2 n_0; \quad \vec{j}_{y1} = ev_{01} n_0; \\ &\vec{j}_{y2} = ev_{02} n_2; \quad \vec{j}_{y3} = -ev_{01} n_3; \quad v_{02} = \frac{hk_{02}}{m}; \\ &\alpha_{k_0}{}^2 = \frac{4v_{01}}{(v_{01} + v_{02})^2}; \quad \beta_{k_0}{}^2 = \frac{(v_{01} - v_{02})^2}{(v_{01} + v_{02})^2}; \\ &v_{02} = \left(v_{01}{}^2 - \frac{2mU_0}{h^2} \right)^{1/2}; \quad v_{01}\left(1 - \beta_{k_0}{}^2\right) = v_{02} \alpha_{k_0}{}^2. \end{aligned} \qquad (4)$$

Let us determine the Hamiltonian of the interaction $H^{(\text{int})}$ of surface plasmons with a stream of charged particles as follows [6]:

$$H^{(\text{int})} = -\frac{1}{c} \int j(r,t) A(r' t) dr, \qquad (5)$$

where

$$\begin{aligned} A(r,t) = &\sum_q \left[\frac{4\pi^2 h |q_x| c^2}{\omega_q S(\varepsilon_{01} + \varepsilon_{02}} \right]^{1/2} \times \\ &\times \vec{e}_\alpha \left[\overset{+}{a}_q(t) + a_{-q}(t) \right] \exp\left(i\vec{q}\vec{r}\right); \end{aligned} \qquad (6)$$

$$\overset{+}{a}_q(t) = \overset{+}{a}_q \exp(-i\omega t); \quad a_q(t) = a_q \exp(-i\omega t);$$

$$\omega_q = \omega_{-q}; \quad S = L_x L_z; \quad |e_\alpha| = 1;$$

$$e_{1x} = e_{2x} = \frac{q_x}{|q_x|} \frac{1}{\sqrt{2}}; \quad e_{1y} = -e_{2e} = -\frac{i}{\sqrt{2}};$$

$$e_{1z} = e_{2z} = 0;$$

Let us represent the operator of current density $\hat{b}_k^+$ in terms of the operators of creation $\hat{b}_k$ and annihilation of electrons. $j(r,t)$.

For incident, transmitted and reflected beam electrons, the current density $j(r,t)$ operator has the form:

$$\begin{aligned} j_1 = &\frac{eh}{2mV} \times \\ &\times \sum_{k_1 k_1'} \left(\vec{k}_1 + \vec{k}_1' \right) b_{k1'}^+(t) b_{k1}(t) \exp i\left(\vec{k}_1 - \vec{k}_1' \right) \vec{r}, \quad y < 0; \end{aligned} \qquad (7)$$

$$j_2 = \frac{eh}{2mV} \sum_{k_2 k_2'} \begin{pmatrix} \left(\vec{k}_2 + \vec{k}_2' \right) \alpha_{k_2'} b_{k2'}^+(t) \times \\ \times b_{k2}(t) \alpha_{k_2} \exp i\left(\vec{k}_2 - \vec{k}_2' \right) \vec{r} \end{pmatrix}, \; y > 0; \qquad (8)$$

$$j_3 = \frac{eh}{2mV} \sum_{k_3 k_3'} \begin{pmatrix} \left(\vec{k}_1 + \vec{k}_1'\right) \beta_{k_3'} b^{+}_{k3'}(t) \times \\ \times b_{k3}(t) \beta_{k_3} \exp i\left(\vec{k}_3 - \vec{k}_3'\right)\vec{r} \end{pmatrix}, \; y < 0, \quad (9)$$

where $\hat{b}_k^{+}(t) = \hat{b}_k^{+} \exp(i\omega t); \quad \hat{b}_k(t) = \hat{b}_k \exp(-i\omega t)$.

The components of the wave vectors k_i' are interconnected by relations (3).

The current densities created by the electrons are written in terms of the diagonal matrix elements of their operators:

$$\overrightarrow{j_i} = \left\langle n_{ki} \middle| j \middle| n_{ki} \right\rangle, \tag{10}$$

$\left\langle n_{ki} \right|, \left| n_{ki} \right\rangle$ – state vectors; $\left\langle n_{ki} n_{ki'} \right\rangle = \delta_{kk}, ...; n_{ki} = (0,1)$ – the number of electrons in the state k_i.

The interaction Hamiltonian can be written in terms $H^{(\mathrm{int})}$ of the matrix element $W^{(i)}_{kiqki^i}$, as follows [7]:

$$H^{\mathrm{int}} =$$

$$= \sum_{i=1}^{3} \sum_{k_i q k_i'} W^{(i)}_{kiqk_i'} \left[a_q^{+}(t) + a_{-q}(t) \right] b^{+}_{ki'}(t) b_{ki}(t); \tag{11}$$

$$W^{(1)}_{k_1 q k_1'} = F \frac{\vec{e}_1 \left(\vec{k}_1 + \vec{k}_1'\right) \alpha_{k_2} \alpha_{k_2'}}{q_x + i\left(k_{1y} - k_{1y}'\right)};$$

$$W^{(2)}_{k_2 q k_2'} = F \frac{\vec{e}_2 \left(\vec{k}_2 + \vec{k}_2'\right) \beta_{k_3} \beta_{k_3'}}{q_x + i\left(k_{2y} - k_{2y}'\right)}; \tag{12}$$

$$W^{(3)}_{k_3 q k_3'} = F \frac{\vec{e}_3 \left(\vec{k}_3 + \vec{k}_3'\right)}{q_x + i\left(k_{3y} - k_{3y}'\right)};$$

$$F = \frac{e}{mV} \left[\frac{\pi h^3 |q_x| S}{\omega_q (\varepsilon_{01} + \varepsilon_{02})} \right]^{1/2} \tag{13}$$

The square of the matrix element of the probability of transitions between states $k \to k'$ for incident, transmitted and reflected particles determines the change in the number of plasmons with time. The matrix element describes the process of forward scattering of an electron in the course of its movement, if the wave vector k_y, coincides in direction with the wave vector k_y. If these vectors are opposite, then the backscattering process takes place.

From expressions (11-13) it can be seen that the matrix elements satisfy the condition of reversibility of direct and reverse transitions:

$$W^{(i)}_{k_i - qk_1'} = W^{(i)}_{k_1' q k_1}.$$

Taking into account the processes of emission and absorption of plasmons in each medium, we obtain a kinetic equation describing the change in the number of plasmons N_q in a state with a wave vector q:

$$\frac{dN_q}{dt} = \frac{2\pi}{h} \times$$

$$\times \sum_{i=1}^{3} \sum_{k_i k_i'} \begin{pmatrix} \sum \left| W^{(i)}_{k_i q k_i'} \right|^2 \delta\left(E_i - E_i' + h\omega_q\right) \times \\ \times \begin{bmatrix} (N_q + 1) n_{k_i'} (1 - n_{k_1}) - \\ - N_q n_{k_1} (1 - n_{k_1'}) \end{bmatrix} \end{pmatrix}. \tag{14}$$

The change is caused by the interaction of the plasmon field with incident transmitted and reflected particles.

When only the processes of induced emission and absorption of waves by particles are taken into account, it is possible to determine from equation (14) the increment (decrement) of plasma oscillations

$$\gamma = \frac{1}{2N_q} \frac{dN_q}{dt}; \quad N_q >> 1.$$

Let the incident, transmitted and reflected particles be described by the Maxwell distribution function, the maximum of which is shifted to the point k_{0i}.

$$n_{ki} = \frac{n_{oi} (2\pi h)^3}{(2\pi mT)^{3/2}} \times$$

$$\times \exp\left(-\frac{h^2 (k_{iy} - k_{oi})^2}{2mT} \right) \exp\left(-\frac{h^2 (k_x^2 + k_z^2)}{2mT} \right), \tag{15}$$

where T – electron temperature n_{oi}- density of particles in the beam. If the plasmon energy is greater than the energy level width, $h\omega >> T$,
then

$$n_{ki} = (2\pi)^3 n_i \delta\left(k_{iy} - k_{oy}\right) \delta\left(k_x\right) \delta\left(k_z\right).$$

Thus, in equation (14) it is possible to sum up over all states of particles at a small width of the energy level of the electron beam compared to the plasmon energy.

As a result, we obtain the value of the increment expressed in terms of the matrix element in the following form:

$$\gamma = \frac{2\pi mV}{h} \sum_{k_{1y}} \sum_{i=3}^{3} \left| W^{(i)} \right|^2 n_{0i} \begin{bmatrix} \delta\left(k_{iy}^2 - k_{i-}^2\right) - \\ - \delta\left(k_{iy}^2 - k_{i+}^2\right) \end{bmatrix}, \tag{16}$$

where $$k_{i+}^2 = \left(k_{0i}^2 \pm \frac{2m\omega}{h} \right)^{1/2}.$$

Summation over positive and negative values of the wave vector describes the processes of electron scattering forward and backward with respect to k_{0i}, and the value of the matrix element is taken at the points $k_i = (0, k_{0i}, 0)$,

If the phase velocity of the wave exceeds the velocity of the particles and the energy of the electron exceeds the energy. plasmon then, replacing the summation in formula (16) by integration, we obtain the increment value:

$$\gamma = \frac{n_0 LV\omega}{hm}\sum_{i=3}^{3}\frac{\left|W^{(i)}\right|^2}{v_{0i}^3}n_{0i}\ , \qquad (17)$$

where $v_{03} = v_{02}$ Substituting the values of the matrix element, we finally find

$$\gamma = \frac{\omega_b^2\left|q_x\right|v_{01}}{2\omega_q^2\left(\varepsilon_{01}+\varepsilon_{02}\right)}\left(1+R^3+D^3\right), \qquad (18)$$

where $\omega_b^2 = \frac{4\pi e^2 n_{0i}}{m}$,

$$D = \frac{v_{02}}{v_{01}}\alpha_{k_{01}}^2$$

is the transmission coefficient, $R = \beta_{k_{01}}^2$ – reflection coefficient of particles from the barrier.

Formula (18) was obtained in the approximation:

$$E_{ki} - U_0 >> h\omega_q\ .$$

It is seen. that the increment does not depend on the sign U_0.

Analysis

Let us present a comparative analysis of the obtained results with the existing ones [8, 9].

If we put U_0 = 0 then from the formula (18) we get the increment

$$\gamma = \frac{\omega_b^2\left|q_x\right|v_{01}}{\omega_q^2\left(\varepsilon_{01}+\varepsilon_{02}\right)}\ .$$

It is half the increment obtained in [8].

This result is related to the fact that in the absence of a potential barrier, initially the states of electrons in the media “1” and “2” are coherent, and when the matrix element of the interaction energy operator is found, the electrons are described by one wave function. In the expression for the increment, the matrix elements in the environments “1” and “2” are added.

In the presence of a potential barrier, the wave functions in the media are different and the squares of the partial matrix elements are added, which leads to the indicated decrease in the increment.

If the plasmon energy is less than the width of the electron energy level

$$\frac{p^2}{2m} >> T >> h\omega\ ,$$

then the number of electron states are related $k\ ;k^{(')}$ by the relation:

.

In this case, surface plasmons decay upon interaction with a stream of charged particles, since the phase volume occupied by particles upon absorption of plasmons exceeds that of radiating particles.

Conclusions

The mechanisms of occurrence of reversible failures of products of semiconductor components of electrical and radio products under the influence of third-party pulsed electromagnetic fields have been studied. It is shown that the presence of a current induced by external radiation leads to the establishment of a mode of amplification of natural oscillations of semiconductor components of a radio product (reversible failures).

A kinetic equation is obtained that describes the change in the number of surfaces plasmons during their interaction with a stream of charged particles crossing the interface between media with an inhomogeneous potential.

The solution of the kinetic equation is given, which makes it possible to determine the influence of the barrier value on the increment of instability of surface oscillations. Obtained contribution to the growth rate of the transmitted and reflected components of the particle flux.

The mechanisms of influence of the potential barrier at the interface between the media of semiconductor components of radio products on the interaction of flows of charged particles induced by an external EMR and surface electromagnetic oscillations are established. Surface plasmons are considered as objects of research.

Calculated relations are obtained that relate the value of the increment instabilities (criterion of reversible failures) with the magnitude of induced currents and the parameters of semiconductor components of radio products: the dimensions of the structure and the magnitude of the potential barrier.

REFERENCES

1. Myrova, L.O. & Chepizhenko, A.Z. (1988), *Ensuring the resistance of communication equipment to ionizing electromagnetic radiation*, Radio and communication, Moscow, 235 c.
2. Mikhailov, M.I., Razumov, L.D. & Sokolov, S.A. (1979), *Electromagnetic influences on communication facilities*, Radio and communication, Moscow, 225 p.
3. Steele, M. and Vyural, B. (1973), *Interaction of Waves in Solid State Plasma*, Atomizdat, Moscow, 312 p.
4. Beletsky, N.N., Svetlichny, V.M., Halameida, D.D. & Yakovenko, V.M. (1991), *Electromagnetic phenomena of the microwave range in inhomogeneous semiconductor structures*, Science thought, Kyiv, 216 p.
5. Zee, C. (1984), *Physics of semiconductor devices*, Mir, Moscow, 456 p.
6. Kravchenko, V.I., Yakovenko, I.V. & Losev, F.V. (2013), “Influence of the flux of charged particles. Induced by external electromagnetic radiation, on the waveguide characteristics of semiconductor components of electrical and radio products”, *Bulletin of NTU “KhPI"*, No. 27, pp. 83–89.

7. Kravchenko, V.I., Yakovenko, I.V. & Losev, F.V. (2013), “Attenuation of surface oscillations of semiconductor structures of electrical and radio products under the influence of external electromagnetic radiation”, *Bulletin of NTU “KhPI"*, No. 27, pp. 96–103.
8. Bayanov, I., Badretdinov, T., Saydivaliev, S., Saliyev, E., Muminov, S. (2022), Influence of Misalignment of Poles on Arcing During Current Collection, Lecture Notes in Mechanical Engineering, pp. 181-190, doi: https://doi.org/10.1007/978-3-030-85057-9_15
9. Zeylikovich, I.S., Nikitin, A.V., Vasilevich, A.E.(2020), Excitation and Detection of a Nonlinear Resonance of Oscillations of a Spring–Mass System Using Electromagnetic Induction, Technical Physics, 65(1), pp. 1-6, doi: https://doi.org/10.1134/S1063784220010284

Received (Надійшла) 07.12.2022
Accepted for publication (Прийнята до друку) 15.02.2023

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Вплив потенційного бар'єру на механізми порушення власних коливань радіовиробів в умовах впливу електромагнітного випромінювання

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Анотація. Предметом дослідження є процес аналізу механізмів виникнення нестійкостей власних коливань напівпровідникових комплектуючих електрорадіовиробів (апаратури зв'язку), за наявності струмів і напруг, наведених імпульсним електромагнітним випромінюванням. електрорадіовироби. **Метою дослідження** є модель трансформації енергії потоку заряджених частинок, наведеного зовнішнім електромагнітним випромінюванням, на енергію власних коливань напівпровідникової структури з урахуванням властивостей самої структури (неоднорідностей потенціалу на кордоні). Реалізація даної моделі обумовлена ефектом перехідного випромінювання зарядів, що рухаються, коли потік частинок перетинає межу розділу середовищ з різними електромагнітними властивостями (діелектричною проникністю) і частина його енергії трансформується в енергію власних коливань напівпровідникової структури. **Цілі такі**:: механізми режиму посилення (нестійкості) коливань напівпровідникових комплектуючих напівпровідникових приладів в умовах впливу імпульсного електромагнітного випромінювання за наявності потенційного бар'єру на межі розділу середовищ, що комплектують виріб. **Методи, що застосовувались при дослідженні**: метод теорії малих обурень, що дозволяє визначити спектр власних коливань системи: наведені електромагнітним випромінюванням струми - власні коливання напівпровідникового приладу. **Отримано такі результати**: Розглянуто взаємодію поверхневих плазмонів із потоком заряджених частинок за наявності потенційного бар'єру, виходячи з енергетичного принципу. Отримано кінетичні рівняння, що визначають зміну числа поверхневих плазмонів, вирази для інкрементів їх нестійкостей з урахуванням величини потенційного бар'єру на кордоні, що призводить до появи відбитих від межі частинок пучка. Результати роботи дозволяють враховувати внесок відбитої та минулої компонент енергії потоку частинок у сумарну енергію випромінювання поверхневих коливань. Досліджено механізми взаємодії потоку заряджених частинок із власними електромагнітними коливаннями двовимірного електронного газу, виникнення якого обумовлено наявністю потенційного бар'єру на межі поділу середовищ. **Висновки**. Визначення режимів посилення (генерації) коливань електрорадіовиробів, що спотворюють їх вольт - амперні характеристики (зворотні відмови) залежно від параметрів зовнішнього електромагнітного випромінювання. Аналіз результатів, отриманих у роботі, може бути використаний при розробці радіовиробів, що працюють у міліметровому та субміліметровому діапазоні (підсилювачів, генераторів та перетворювачів частоти). Оцінки показників експоненційного зростання амплітуд власних коливань напівпровідникових комплектуючих приладів (інкременту нестійкості як критерію оборотних відмов) показують, що величина енергії випромінювання лежить у межах чутливості сучасних приймачів випромінювання субміліметрового діапазону і є причиною виникнення відмов.

Ключові слова: наведений струм; електромагнітне імпульсне випромінювання; напівпровідникові комплектуючі; поверхневі коливання; нестійкість коливань.