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GENERALIZED EMC CHARACTERISTICS OF RADIO RECEIVING SYSTEMS

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Abstract: the results of radio receiving systems and its parts – receivers and receiving antennas generalized electromagnetic compatibility (EMC) parameters substantiation is contained. Values of these parameters are unequivocally connected with danger (probability) of infringement of EMC in typical electromagnetic environment presented in spatially - dispersed groupings (fields) of radio systems. Definition of these parameters supposes automation of their measurements with use of modern universal radio measuring devices and systems

Keywords: radio receiver, antenna, power flux density, probability, electromagnetic environment

1. INTRODUCTION

In process of solving problems related to EMC of radio systems (RS), a large number of particular parameters and EMC characteristics of radio receiving systems (RRS) and its parts – radio receivers (RR) and radio receiving antennas (RRA) is used. These characteristics and parameters describe certain RRS properties, critical from the viewpoint of interferences and possibilities of their prevention. In particular, the following may be considered among these characteristics:

- for the RR – the characteristics and parameters of the primary, intermediate and image channels selectivity, the selectivity characteristics and parameters with respect to nonlinear effects;
- for the RRA – the characteristics and parameters of amplification and selectivity (spatial, frequency and polarization), including parameters of the antenna pattern in the horizontal and vertical planes (the characteristics of the main beam, relative levels and position of the side and back lobes in the antenna pattern; dependence of the beam shape and parameters on the frequency and polarization) etc.

As the spatial density of RS grows, the electromagnetic environment (EME) as the ensemble of electromagnetic fields (EMF), present at a certain spatial point, is getting more complicated. On the other hand, the actual susceptibility of the human environment to electromagnetic fields simultaneously rises as long as the spatial density of technical systems - possible sensors of interferences - is increased.

Thus, the RS operation conditions are getting more and more complicated. As a result, there is a trend in expanding the number of specific EMC characteristics and parameters of RR and RRA. And here some of the specific EMC parameters appear to be mutually inconsistent or contradicting the critical (functional) parameters of RS(susceptibility and the radio reception bandwidth, beam width and amplification of the main beam, etc.): improvement of one of these parameters may degrade another one or some of them. Therefore, in general, expanding the number of the particular EMC parameters and characteristics of radio equipment

- makes the complete cycle of measurements of the whole set of these parameters and characteristics when performing industrial and certification quality assurance of industrial products, more complicated and expensive, and in this case
- it is very often the case, when the measurement data does not ensure the required level of objectivity when RS are comparatively analyzed by the EMC criterion.

The latter circumstance may be accounted for the following. Particular EMC parameters and characteristics describe certain specific physical properties of the equipment, defining its imperfection from the EMC viewpoint. However the measured values of these parameters and characteristics do not express the actual risk (probability) of these properties manifesting themselves in future operation conditions, that is, how significant the described physical properties are from the standpoint of the system's capability of incapability to operate in a certain EME and not to generate intolerable radio interferences to other systems under these conditions. The reason is vagueness of the expected operation conditions: randomness, diversity and variability of the expected EME.

Therefore the objective comparative EMC analysis of RRS and its elements (RR, RRA), intended for use under undefined (random, variable) conditions, is essential to carry out on a system level, implied the following:

- outlining the operation conditions (EME), for which the comparative EMC analysis of RRS is performed (in particular, determining typical or standard EME);
- defining generalized system's RRS (RR, RRA) EMC parameter (criterion), based on which each type of this objects will be compared under the accepted operation conditions. The meaning of this parameter should be the weighted sum of the particular RRS (RR, RRA) EMC characteristics/parameters. The weights, used to process the sum, are supposed to ensure the necessary scaling of the particular items and to be linked to occurrence probabilities (hazards, risks) of certain physical properties (types of imperfections) of RRS (RR, RRA) that could upset the EMC of RS under the accepted typical operation conditions. For instance, it is possible to accept a parameter, directly correspond to the probability of interference in typical EME as such a criterion;
- defining the rules and procedures to calculate the generalized system EMC criterion for RRS (RR, RRA) with respect to the accepted operation conditions using the results of the specific EMC parameters and characteristics measurements, as well as justification of the essential procedures of direct theoretical and experimental estimation of the values of such generalized system EMC criterion with respect to the accepted EME.

The system EMC parameters obtained in this manner, are supposed to ensure the following:

- to provide a principal possibility of the generalized qualitative and quantitative description of EMC as of a capability to satisfactorily perform its functions under typical EME (for RRS, RR) or to protect against interference (for RRA);
- the possibility of an adequate comparative EMC estimation «in general» for radio equipment that have identical purpose in typical EME;
- the convenience and low labor-intensity of their estimation in terms of computing and experimental methods, including the possibility to measure it employing the existing park of state-of-the-art multi-functional and specialized measurement tools and test equipment in laboratory conditions, and also to make estimations by the set of the measured specific EMC parameters and characteristics;
- to have defined and natural application along with basic functionalities and parameters of devices, that describe their performance characteristics, in particular, such as sensitivity and primary channel bandwidth for RR, gain and main beam width for RRA, etc.;
- to ensure direct link to the measure of RS usage the radio frequency resource (RFR) as to the RSEMC parameter of higher hierarchical level.

An attempt of systematized description of defining and estimating the RRS (RR, RRA) generalized EMC characteristics being further development of [1,2] with respect to the most widespread radio-system operation conditions, typical for their space-scattered fields (groupings) is sited below.

2. BASIC STATISTICAL MODEL OF THE RRS OPERATION CONDITIONS IN SPACE-SCATTERED GROUPINGS (FIELDS)

The space-scattered grouping (SSG) of RS – EMF emitters is a grouping of radio systems, located in space of a sizable volume or on a territory of a large area; the geometry of the grouping exceeds considerably the sizes of the near-field emission/reception region of each radio transmitter (the plane electromagnetic wave model is applied) and are determined with such categories as «line-of-sight», «critical interference range», «coordination distance», etc.

Scattered distribution of radio equipment within a SSG may be considered random practically always, owing to the fact that the equipment belongs to different users, as well as to influence of the relief and morphology of the earth's surface, and other factors. The well-known Poison model of random point arrangement in space may be employed as a model for probabilistic mode of space-scattered distribution of radio equipment:

$$p_k(N_{\Delta V}) = \frac{N_{\Delta V}^k}{k!} exp(-N_{\Delta V}), \qquad (1)$$

where $p_k(N_{\Delta V})$ is the probability of occurrence in some element ΔV in space of only k of point objects (devices), if the average number of objects in this element is $N_{\Delta V}$. If the average spatial density of radio equipment within element ΔV equals to ρ, then $N_{\Delta V}=\rho\cdot\Delta V$. This model finds quite a wide application for simulation of space-scattered networks (fields) of sources and receivers of EMF; in particular, its involvement in [3,4] is worth mentioning.

For the majority of kinds of radio equipment the typical value of its spatial density may be determined considering the observed at the moment or expected intensity of its use. In particular, for the cellular communication means the number of mobile stations may be accepted up to 80-120% of the population density, or from predictions given in [5,6].

We shall apply a commonly known hyperbolic approximation of the dependence of the electromagnetic field power flux density **Π** on distance **R** to its source as a model of radio waves propagation (RWP) conditions:

$$\Pi = C_\nu P_{etr} \big/ R^\nu,\ P_{etr} = G_a P_{tr},\ C_\nu = const, \qquad (2)$$

where P_{etr} is the equivalent isotropic radiated power (e.i.r.p.), P_{tr} stands for the power, applied to the source's antenna; G_a - antenna gain, C_ν is constant, ν means the parameter, that determines the «rate» of the electromagnetic field fading as the distance to the EMR source increases (ν=2 in case of RWP in free space; in a number of cases it is possible to use values ν=4 (in case RWP is with interference of direct and reflected beams in the far-field region for the VHF range and lower UHF range, as well as in case of preliminary consideration of the RWP path shading affecting the mobile communication systems being caused by urban build-up and vegetation); ν=8 for the HF range (decameter waves); ν=2÷12 in case of indoor RWP in the UHF range) [7-9].

The nature of the dependence (2) proves, that when analyzing or simulating the spatial distribution of radio signal sources, it is reasonable to be restricted by some region in space around the location point of the concerned RRS - a receptor of interference: the region of potential (possible) interference. We shall define it as the domain in space with its center in the location point of the RRS, beyond this region the e.i.r.p. of systems - EMF sources is insufficient to interfere with the RRS in the concerned location point (the EMF power flux density in the point of the RRS location, radiated by RS beyond this domain, is less than the susceptibility threshold at the antenna input of the RRS.

The spatial domain of the potential interference (DPI) to the RRS the shape of a sphere or a circle having its radius

$$R_{max} = \left(C_\nu P_{etr} / \Pi_{min}\right)^{1/\nu} \qquad (3)$$

around the point of the RRS, the susceptibility threshold of which is Π_{min} .

Estimation of R_{max} makes it possible to find the average number of systems –the interference sources within the DPI. In particular, in cases of geographical and spatial location of RS – EMF sources within this domain we shall respectively have

$$N_{Scp} = \int_0^{R_{max}} \int_0^{2\pi} R\,\rho(\alpha, R)\, d\alpha\, dR; \qquad (4)$$

$$N_{Vcp} = \int_0^{R_{max}} \int_0^{2\pi} \int_{-\pi/2}^{\pi/2} R^2 \rho(\alpha, \varepsilon, R) \cos(\varepsilon)\, d\varepsilon\, d\alpha\, dR\,,$$

where $\rho(б,R)$ [sources/km^2] and $\rho(б,e,R)$ [sources /km^3] are functions of the average spatial density of sources within the considered domain in polar and spatial coordinates correspondingly.

The Poisson model (1) describing the random location of EMF sources with the average spatial density $\rho(б,R)$, $\rho(б,e,R)$ in the DPI with the radius as (3) around the considered RRS, determines the basic properties of the basic statistical model for the RRS's operation conditions.

The situations, when random spatial location of radio equipment within the DPI may be considered uniform ($\rho(б,R)=const_S$, $\rho(б,e,R)=const_V$, $R \le R_{max}$) are of the greatest interest. The following basic characteristics of the operation conditions for the considered RRS, positioned in the centre of this domain, may be determined for these situations [7]:

1. Hyperbolic probability distribution density (p.d.d.) of the EMF's power flux density (PFD) in the point of the RRS location is:

$$w(\Pi) = \frac{m \Pi_{min}^{m/\nu}}{\nu \Pi^{(m+\nu)/\nu}}\,; \;\; \Pi \ge \Pi_{min}\,, \qquad (5)$$

where parameter m characterizes the considered type of the EMF sources spatial location: m=**1** in case of linear distribution of sources, m=**2** in case of geographical distribution of the sources, m=**3** in case of their spatial distribution; the left boundary Π_{min} of the signal PFD definitional domain is the susceptibility threshold of the RRS.

For the uniform random distribution and equiprobable radiation directivity of the RT - the interference source in the DPI with its boundaries determined by (3), it is possible to prove practical invariance of the distribution kind (5) to the e.i.r.p. distribution kind of the EMF sources and to fading.

2. P.d.d. of EMF's non-power parameters (selection parameters) in the RRS input: for the uniform random location of the EMF sources within the DPI these parameters may be considered statistically independent: $w(x_1,\ldots,x_n) = =w(x_1)\ldots w(x_n)$. In this case the following models may be used [7]:

– uniform p.d.d. of EMF frequencies $x_1 = f \in [F_{max}, F_{min}]$, of azimuth of the EMF direction of arrival $x_2 = \alpha \in [0, 2\pi]$ and of EMF polarization $x_3 = \varphi \in [0, \pi/2]$:

$$w(f) = \frac{1}{F_{max} - F_{min}}\,, \quad w(\alpha) = \frac{1}{2\pi}\,, \quad w(\varphi) = \frac{2}{\pi}\,; \qquad (6)$$

– p.d.d. of the viewing angle x_4=e of the EMF sources, when the RRS is located at an altitude H over the earth's surface with its radius R_3 , where the RT as the EMR sources, are distributed:

$$w(\varepsilon) = \frac{2}{ctg^2 \varepsilon_{min}} \cdot \frac{\cos\varepsilon}{\sin^3 \varepsilon}\,, \quad \varepsilon \in [\varepsilon_{min},\ \pi/2],\ \varepsilon_{min} = \varepsilon_H / 2\,, \quad \varepsilon_H = \arccos[R_3 / (R_3 + H)\,;] \qquad (7)$$

Thus, the basic statistical model of the RRS operation conditions in SSG of RS may be presented as a random uniform distribution of EMF sources within the PDI with the radius (3) («Poisson» stochastic conditions with constant density), that ensures for the RRS as the interference receptor located in the DPI center, presence at its input of ensemble of N signals having random parameters; the number N signals in the ensemble is random, the average number $N_{\Delta V}$ of signals in the ensemble may be derived from (4), the signal parameters may be considered statistically independent and distributed in compliance with (5)-(7)

In case if EMF sources emit not continuously, but in sessions, and the operation when emitting is A**%** of time, the average number of signals at the reception point is $N_{\Delta V} \cdot A/100$, the actual number **N** of signals at a definite moment is random and distributed according to the Poisson model (1). In particular, this situation is typical for the mobile communication mobile stations; for these devices A=1…5%.

3. GENERALIZED EMC PARAMETER OF RRS

Let us recall the basic RRS functions:

a) capturing radio waves, carrying information, in a form of preselection of electromagnetic fluctuations by its direction of arrival and polarization parameters, as well as conversion of electromagnetic into RF electrical fluctuations;

b) conversion of the received RF fluctuation into either voltage or current, varying as per the transferred message, for this purpose the useful signal interference frequency or time-domain filtering is performed as well as its amplification to the desired level and its detection;

c) reproduction of the transferred message in a form of physical process (electrical, acoustic, mechanical, etc.), containing the received information.

The EMC of radio system is commonly determined by the quality of performing by its RRS the two first functions (RRS functions a,b). Therefore from the EMC standpoint, the following should be considered among the most important RRS characteristics:

- its interference susceptibility, that is characterized by the susceptibility PFD threshold Π_{min}; this RRS parameter is linked to the RRS sensitivity Π_0 to the useful signal through the protective ratio **G** (minimal allowable "signal / intrinsic noise + interference ratio") at the RRS input:
- Π_{min}[W/m^2] = Π_0[W/m^2] / G[units];
- Π_{min}[dBW/m^2] = Π_0[dBW/m^2] - G[dB];
- according to (3),(4) the parameter Π_{min} determines the DPI size and the amount of radio interferences that exceed a level of the RRS susceptibility at its input at the point of its spatial location; the higher is the susceptibility (lower the value of Π_{min}), the greater number of EMFs has to be taken into account as potentially hazardous for the radio reception;
- its selectivity characterizing the RRS capability to extract the useful EMF (radio signal) out of the aggregate of electromagnetic fluctuations, present at the RRS point of location; this RRS property may be described by characteristic $K(x_1,x_2,...,x_n)$ of the normalized RRS selectivity by non-power parameters $x_1,x_2,...,x_n$ of EMFs (radio signals) – polarization, direction of arrival, arrival frequency and time, etc.);

the higher is the RRS susceptibility, the lower is the probability that unwanted signals would interfere at its IF output (detector input) having levels, hazardous for the processes of detection and further reproduction of the message transferred.

The mentioned RRS characteristics will finally determine the hazard (the probability) of present at its RRA input unwanted signals arriving along with the useful signal to the RRS output. This probability may be defined using the models and relationships (1.4)-(1.8) presented above, as well as employing a model of the RR designed as concatenated multi-dimensional filter with the susceptibility characteristic (in power) of $K(x_1,x_2,...,x_n)$ and thresholder, ensuring the level selection of Π_{min}.

We shall restrict ourselves by considering a uniform random distribution of radio devices as the interference sources within the DPI with some average spatial density. For the preset RRS susceptibility threshold Π_{min} and fixed e.i.r.p. P_{etr}. of the interference sources, the average number of radio interferences at the RRA input will be:

$N_{in\,1} = 2R_{max}\rho_1$ in case of linear distribution of radio devices in the DPI with the density of c_1 [units/km];

$N_{in\,2} = \pi R_{max}^2 \rho_2$ in case when radio devices are distributed over the DPI with the density of c_2 [units/km^2];

$N_{in\,3} = \frac{4}{3}\pi R_{max}^3 \rho_3$ in case of spatial distribution of radio devices in the DPI with the density of c_3 [units/km^3];

With the preset probability distribution density of $w(x_1,x_2,...,x_n)$ of input emissions by the selection parameters $x_1,x_2,...,x_n$

- the probability that an arbitrary selected signal out of the totality N_{in} would arrive into the elementary interval $dx_1dx_2...dx_n$ at the point of n-dimensional susceptibility space with coordinates $x_1,x_2,...,x_n$ may be expressed as $v_S(x_1,x_2,...,x_n)=w(x_1,x_2,...,x_n)\ dx_1dx_2...dx_n$, and in this case this signal's fading will equal to the value of the function $K(x_1,x_2,...,x_n)$ at this point;
- consequently taking into account the distribution (1.5) the probability that this arbitrarily selected signal if arrives into the elementary interval $dx_1dx_2...dx_n$ at the point with coordinates $x_1,x_2,...,x_n$ will exceed in level the RRS susceptibility threshold Π_{min}, will be

$$v_L(x_1,...,x_n) = \int_{\Pi_{min}/K(x_1,...,x_n)}^{\infty} w(\Pi)\,d\Pi\,. \qquad (8)$$

Therefore, the average number of interfering signals exceeding in level the threshold Π_{min} and capable of arriving to the RRS output through the elementary interval $dx_1dx_2...dx_n$, will be $dN_{out}(x_1,x_2,...,x_n)=N_{in}\cdot v_S(x_1,x_2,...,x_n)\cdot v_L(x_1,x_2,...,x_n)$, hence, integrating by the domain of existence of each of the selection parameters $x_1,x_2,...,x_n$, we shall obtain the average number of interfering signals at the RRS output, exceeding in level the threshold Π_{min} :

$$N_{out} = N_{in} \int_{(x_1)}\!\!...\int_{(x_n)} w(x_1,...,x_n)\cdot \int_{\Pi_{min}/K(x_1,...,x_n)}^{\infty} w(\Pi)\,d\Pi\, dx_1...dx_n = \qquad (9)$$
$$= N_{in} \int_{(x_1)}\!\!...\int_{(x_n)} K^{\frac{m}{\nu}}(x_1,...,x_n)\, w(x_1,...,x_n)\,dx_1...dx_n\,.$$

The probabilistic mode of distributing the "signal" point with coordinates $x_1,x_2,...,x_n$ in the n-dimensional space of selectivity $\{Dx_1,Dx_2,...,Dx_n\}$ may be accepted as Poisson of (1) expression, then the probability $v_D(\geq 1)$ of the RRS hit with at least one interference out of N_{in} present at the RRS input, will be equal:

$$v_D(\geq 1) = 1 - exp(-N_{out}).$$

Cases when this probability is low, which may be gained with N_{out}<<1 are of a certain practical interest. For these cases it may be assumed, that the major hazard for a radio receiver are the cases of single signals, and couples, triplets and greater numbers of signals at a time may be neglected. Therefore

$$v_D(\geq 1) \approx N_{out}\, exp(-N_{out}).$$

Evidently, it is always possible to assume such a severe EME, when any most advanced and perfect RRS will be hit with interference. Therefore it is reasonable to normalize the RRS capability to extract the useful signal out of the totality of interfering signals in a certain standard EME, where normal operation of the RR is possible with a certain allowable probability. Here it is essential that this normalized radio receiver characteristic

- be invariant with respect to the complicated nature of EME (to the number of signals (interferences) at its input),
- be determined by the basic physical properties of the RR (sensitivity /susceptibility and selectivity)
- be dependent on basic statistical EME characteristics – signal probability distribution laws by the power and selection parameters that is on the basic features of the operation conditions in what concerns the spatial distribution of radio devices as the interference sources and the RWP conditions.

A relative average number of input signals, exceeding in their level the RRS susceptibility threshold and capable of arriving at its output may be considered such a normalized characteristic to be accepted as the RRS EMC system parameter:

$$Q_{RRS} = \frac{N_{out}}{N_{in}} = \int\limits_{(x_1)}\dots\int\limits_{(x_n)} K^{\frac{m}{\nu}}(x_1,\dots,x_n)\,w(x_1,\dots,x_n)\,dx_1\dots dx_n. \qquad (10)$$

This parameter links the probability that the RRS is hit with interferences $v_D(\geq 1)$ to the parameter N_{in} , that characterizes complexity of the operation conditions (EME) and to the parameters m, ν , that describe basic regularities of spatial distribution of radio devices as the interference sources (m) and basic RWP regularities (ν). With the given probability $v_D(\geq 1) \leq v_{Dmax}$ for the RRS with the preset EMC ($Q_{RRS}=Q_{RN}$) it is possible to restrict the maximum permissible EME complexity:

$$N_{in} \leq -\frac{ln(1 - v_{Dmax})}{Q_{RN}}. \qquad (11)$$

In case of the RRS the frequency f and the time selection t is performed by the RR practically always, as for the selection by the parameters of the signal direction of arrival $б,е$ and polarization $ц$ – by the receiving antenna. The probability distribution for the signals, forming the EME at the point of radio reception, for each of these sets of parameters may be recognized as independent. Therefore the RRS EMC system parameter may be presented as a product of the generalized receiver EMC system parameter Q_{RR} and those of the RRA Q_{AR}:

$$Q_{RRS} = Q_{AR}Q_{RR};$$

$$Q_{AR} = \frac{N_{AR\,out}}{N_{in}} = \int\limits_{(\alpha)}\int\limits_{(\varepsilon)}\int\limits_{(\varphi)} K_{AR}^{\frac{m}{\nu}}(\alpha,\varepsilon,\varphi)\,w(\alpha,\varepsilon,\varphi)\,d\alpha\, d\varepsilon\, d\varphi; \qquad (12)$$

$$Q_{RR} = \frac{N_{out}}{N_{AR\,out}} = \int\limits_{(f)}\int\limits_{(t)} K_{RR}^{\frac{m}{\nu}}(f,t)\,w(f,t)\,df dt;$$

in the given relationships $K_{AR}(б,е,ц)$ is the normalized selectivity characteristic of the RRA, $K_{RR}(f,t)$ is the normalized selectivity characteristic of the RR, $N_{AR\ out}$ - average number of interfering signals at the RA output, exceeding in their level the power susceptibility threshold of the RR $P_{min}=П_{min}\cdot A$ (where A is the receiving antenna effective area).

4. DEPENDENCE OF Q-PARAMETER ON A LEVEL OF RR INITIAL NOISE

The RRS susceptibility threshold $П_{min}$ is connected with RR noise properties and frequency selectivity:

$$П_{min} = \frac{P_0}{AG} = \frac{k(T_0 + T_{NR})\Delta F_{NR} D}{AG},$$

here P_0, T_{NR} – RR threshold sensitivity and noise temperature correspondingly, A_R – RRA effective area, $ДF_{NR}$ – RR noise frequency band, T_0 – noise temperature of RRA, k – Boltzmann constant, G – minimally necessary protective ratio (SIR), D - minimally necessary factor of discernability of a useful signal (SNR) in own RR noise.

We shall be limited to consideration in RRS only frequency selectivity At uniform distribution of signals in a frequency band $DF=Fmax-Fmin$ covering a RR band $ДF_{NR}$<<DF. For rectangular idealization of RR frequency response function we shall receive:

a) at location EMF sources along a line (m=1)

$$N_{out\,1} = \frac{\Delta F_{NR}}{DF} N_{in\,1} = \frac{2\rho_1}{DF}\left(\frac{A\,G\,C_\nu P_{etr}}{k(T_0 + T_{NR})D}\right)^{1/\nu} \Delta F_{NR}^{\ \nu - 1/\nu};$$

for free RWP (ν=2)

$$N_{out\,1} = \frac{2\rho_1}{DF}\left(\frac{A\,G\,C_\nu P_{etr}}{k(T_0 + T_{NR})D}\right)^{1/2} \Delta F_{NR}^{\ 1/2};$$

for "interferential" RWP (ν=4)

$$N_{out\,1} = \frac{2\rho_1}{DF}\left(\frac{A\,G\,C_\nu P_{etr}}{k(T_0 + T_{NR})D}\right)^{1/4} \Delta F_{NR}^{\ 3/4};$$

b) at location EMF sources on a surface (m=2)

$$N_{out\,2}=\frac{\Delta F_{NR}}{DF}N_{in\,2}=$$

$$=\frac{\pi\rho_2}{DF}\left(\frac{A\,G\,C_\nu P_{etr}}{k(T_0+T_{NR})D}\right)^{2/\nu}\Delta F_{NR}{}^{\nu-2/\nu};$$

for free RWP (ν=2)

$$N_{out\,2}=\frac{\pi\rho_2}{DF}\left(\frac{A\,G\,C_\nu P_{etr}}{k(T_0+T_{NR})D}\right);$$

for "interferential" RWP (ν=4)

$$N_{out\,2}=\frac{\pi\rho_2}{DF}\left(\frac{A\,G\,C_\nu P_{etr}}{k(T_0+T_{NR})D}\right)^{1/2}\Delta F_{NR}{}^{1/2};$$

c) at location EMF sources in volume (m=3) for free RWP (ν=2)

$$N_{out\,3}=\frac{\Delta F_{NR}}{DF}N_{in\,3}=$$

$$=\frac{4\pi\rho_3}{3\,DF\sqrt{\Delta F_{NR}}}\left(\frac{A\,G\,C_\nu P_{etr}}{k(T_0+T_{NR})D}\right)^{3/2}.$$

Thus, increase in RRS sensitivity, achievable due to narrowing a radioreception frequency band and corresponding reduction of a level of initial thermal noise, at identical average spatial density of sources and identical RWP conditions within the DPI:

- can not affect on average number of interfering signals, exceeding threshold Π_{min} and capable to penetrate on RSS output (location EMF sources on a surface (m=2) at free RWP ((ν=2)), or
- can be accompanied by increase in an average number of the interfering signals, exceeding threshold Π_{min} and capable to penetrate on RSS output (location EMF sources along a line (m=1) at "interferential" RWP (ν=4)), or
- can be accompanied by decrease in an average number of this signals (location EMF sources in volume (m=3) at free RWP (ν=2)).

These conclusions are paradoxical to some extent , as they testify that with increase in dimension of spatial accommodation of EMF sources (with changing of parameter m from 1 up to 3) influence of narrowing of RRS frequency band on improvement its EMC grows, though it would be possible to assume the opposite.

5. CONCLUSION

In the author's opinion, using the above-described generalized EMC system characteristics (**Q**-characteristics) featuring the RRS and their elements (RR and RRA) in combination with the most significant standard parameters of RS, that determine its performance characteristics, would allow to improve the objectivity of the EMC technical requirements to the RS when applied to space-scattered groupings, as well as to expand the range of possible tools employed to ensure EMC in RS by of re-distributing the efforts aimed at improving certain particular technical characteristics of their elements. It is very important, that the above generalized EMC characteristics are directly linked to the characteristics of the frequency resource as used (occupied) by the RS, as well as are simple to be applied for measurements that use traditional panoramic RRS selectivity measurement systems and standard measurement set-ups to control the antenna patterns. The latter proves the possibility to employ the presented generalized EMC characteristics in practice, as well as the fact, that their application will enable to enhance the efficiency of expensive radio frequency resource.

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