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Radio Engineering Characteristics of the Spatial Distributed Casual Antennas: Methods of Parameters Determination Taking Into Account Nonlinear Properties

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Abstract

Calculation and experimental methods definitions of the main characteristics of the spatial distributed casual antennas (SDCA) in a wide strip of frequencies are given: the operating height (length), the effective area, an effective surface of dispersion. The specifics of casual antennas influencing their parameters in the modes of reception and radiation of electromagnetic waves are analyzed. The description of the SDCA nonlinear properties is provided and useful possibility of casual antennas for electromagnetic radiations masking by method of an intermodulation noising locates. Technical result of this article is increase of accuracy of measurement of the operating length spatially of the distributed casual antenna by means of the accounting of a structural component of characteristics of dispersion of the antenna.

Identification and overlapping of channels of leakage of confidential information on such casual antennas which are available in the rooms which are subject to protection is important for ensuring information security. In models of an assessment of efficiency of information security as basic data it is necessary to have exact information on the operating length spatially of the distributed casual antenna.

Keywords: low density code, noise generator, decoding, frequencies strip, the operating height and the effective area of the antenna, the spatial distributed casual antenna, intermodulation, the effective area of dispersion

INTRODUCTION

Introduce the problem

Now in connection with complication of problems of ensuring electromagnetic compatibility (EMC) of radio electronic facilities (REF), and also information security from leak on electromagnetic channels great scientific and practical interest represents studying of properties of the spatial distributed casual antennas (SDCA). Unlike specially developed and designed REF regular antennas such casual antennas represent conductors and elements with often a priori unknown difficult configuration.

The SDCA Classification and properties are investigated in works [1,2]. Owing to the galvanic, capacitive and (or) inductive coupling combined generally the casual antennas (CA) elements form or accept the electromagnetic radiations influencing quality of work of REF and technical means. Uncertainty of geometrical and physical parameters (the sizes, physical properties, the mutual spatial provision of elements, polarization) results in complexity in definition of electric characteristics of such antennas. The characteristic differences of casual antennas from regular antennas influencing their electric characteristics are:

- casual nature of placement and excitement linearly extended, the spatial distributed or plane conducting elements (a chain of the alarm system, management, grounding, power supply, water and heating communications, conductors, payments, panels, etc.). Probabilistic character of characteristics of radiation, reception and dispersion of casual antennas is a consequence of this factor;

- modeling of SDCA, which interfere with reliable calculation of characteristics of such antennas, is difficult, for example, of the operating length or the effective area calculation;

- existence of numerous parasitic communications between elements of the casual antenna of galvanic, inductive and (or) capacitor character;

- useful or parasitic radio engineering uncoordinated loading which is implicitly expressed or absent at SDCA ;

- structure of SDCA exists elements with nonlinear electric properties (oxide contacts, radio components with the nonlinear volt-ampere characteristic, inductance, parametrical contours, etc.).

The problem of the main antenna definition characteristics of resonant and aperture SDCA , such as the operating height, the effective area matters for the solution of the applied tasks connected with providing EMC of radio electronic facilities and information security. Problems with identification of loading at SDCA can be partially compensated by definition along with antenna electric characteristics and the effective surface of dispersion (ESD). The knowledge of a ratio between ESD and the effective area of such antenna allows to find SDCA properties: whether is it the parasitic antenna or a passive repeater of electromagnetic waves.

METHODS

Justification of the main characteristics of spatial distributed casual antennas

Definition 1. The operating height of the transferring SDCA is the operating height such equivalent to it on properties of the nonrandom resonant antenna of a simple geometrical form which is defined as proportionality coefficient between the intensity of a field created by the equivalent antenna, and tension given on its entrance:

$$h_e = \frac{U_{in}}{E} \quad (1)$$

Definition 2. The ESD of the transferring SDCA is the effective area such equivalent to it on properties of the nonrandom aperture antenna of a simple geometrical design which is defined as proportionality coefficient between the power of a signal given on an entrance of the equivalent antenna and density of a stream of power of the radiation created by it in the axial direction:

$$S_{ef} = \frac{P_{in}}{\Pi} \quad (2)$$

Definitions 1 and 2 allow to estimate the operating height and the effective area of the transferring casual antennas in the standard terminology, and both for SDCA with expressed, and for SDCA with obviously not expressed radio engineering loading.

Definition 3. Ratio view:

$$A = S_{ef} * I * \delta \quad (3)$$

where- ESD of the casual antenna, characterizes SDCA properties: than more effective area, especially the SDCA antenna properties are obviously expressed and this casual antenna has the coordinated absorbing radio engineering loading and vice versa, than it is more than ESD of the casual antenna, especially the disseminating SDCA properties (in a limit the antenna has no loading) are obviously expressed. Dependences schedule of the antennas effective area on ESD is demonstrated on the figure 1.

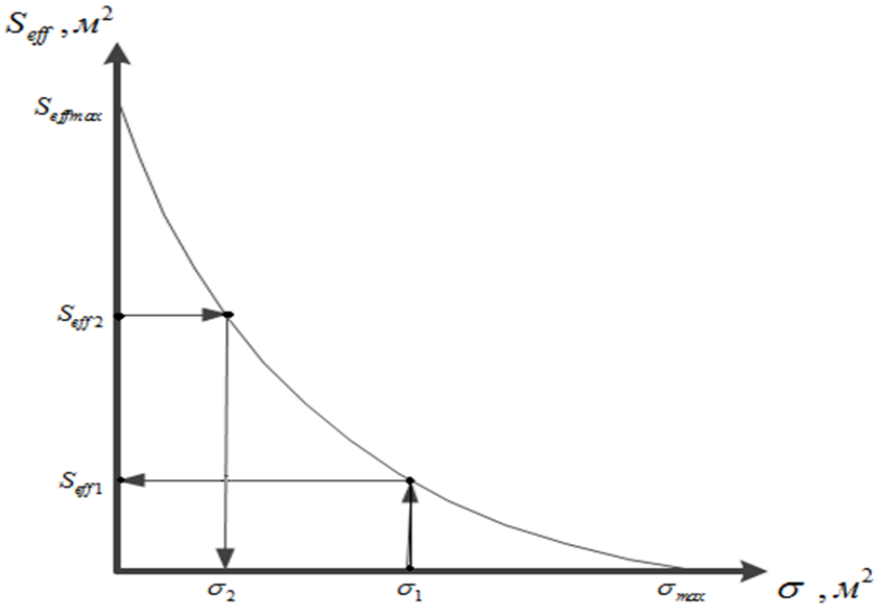

Figure 1: Dependences schedule of the antennas effective area on ESD

The schedule can be constructed on two extreme points on abscissa axes and ordinates, to the corresponding maxima of ESD and the effective area. On graphics it is shown how on known (for example, measured) value of the effective area of the casual antenna can determine simply it by ESD and vice versa.

The principle of non-reciprocity of antenna gain factors of casual antennas on transfer and reception

For regular antennas the principle of reciprocity (reversibility) is fair: the strengthening coefficient (SC) of the reception antenna corresponds to of antenna gain factor (AGF) of the same antenna during its work on transfer. However for SDCA this principle isn't carried out. The AGF divergence of casual antennas on reception and on transfer is explained by the following.

We will consider a situation of work of SDCA on reception. At radiation of the casual antenna an external electromagnetic field the considerable part of the electromagnetic energy of radiation falling on it is reflected in the opposite direction and dissipates in space in other directions the disseminating SDCA elements. This phenomenon is caused by that circumstance that generally the SDCA elements are distributed in space, it has no obviously expressed radio engineering loading for absorption of the energy falling on it, or isn't coordinated with the available loading. SDCA has no most important property of the regular antenna: absorption of the most part of the electromagnetic energy falling on it in the coordinated loading. The efficiency of such antennas is in most cases extremely low there sore the strengthening coefficient is also not high.

In case of work of SDCA on transfer of a condition of transmission of energy from an equivalent of radio engineering loading or a source of primary radiation towards the radiation of an electromagnetic wave generally differ from conditions, characteristic for reception of radio waves in the casual antenna there sore coefficients of strengthening of SDCA on transfer and reception naturally differ.

It should be noted that unlike the approach accepted in antenna equipment (the efficiency is defined by losses on radiation resistance) the efficiency of the casual antenna considers losses on dispersion of radio waves, and also the losses caused by a loading mismatch with the antenna. As it is known [3 - 15], the effective surface of dispersion of antennas has two components: antenna and structural. In casual antennas the structural component is more obviously expressed. The structural component of ESD is caused by dispersion of electromagnetic waves on the reflecting antenna design elements. The antenna component of ESD depends on conditions of coordination of the antenna with loading and is naturally shown in casual antennas as the part of the electromagnetic energy falling on the antenna comes back in the opposite direction because of reflection from loading, uncoordinated on wave resistance. During the work on transfer the casual antenna has other conditions for formation of an electromagnetic field in space, namely:

- the direction of transfer of electromagnetic energy in the casual antenna changes on opposite, thus the transfer characteristic of a path of passing of energy generally (because of existence of not linearity) changes;

- antennas and structural components of dispersion at the radiation are absent;

- at identical values of power on an antenna entrance during the work on transfer and capacities at the antenna exit during its work to reception power stream density in a zone of its radiation (reception) differs.

Thus, in casual reception antennas unlike regular antennas the considerable part of the falling electromagnetic energy dissipates in space due to existence structural and the antenna making ESD. In most cases SDCA works as the low-quality antenna and at the same time as the lens (reflector) of radio waves. Quantitatively degree of difference of SDCA from the regular antenna can be estimated on the basis of an indicator (3). Than value of this indicator is more, especially SDCA possesses properties of the real antenna.

The principle not of reciprocity of SDCA dictates need of a formulation of definitions for the operating height and the effective area of such antennas.

Definition 4. The operating height of reception SDCA is the operating height such equivalent to it on properties of the nonrandom resonant antenna of a simple geometrical form which is defined as proportionality coefficient between intensity of the falling field in a zone of placement of the antenna, and stress removed on the coordinated or uncoordinated loading at the antenna exit:

$$h_{er} = \frac{U_{out}}{E_{in}} \tag{4}$$

At practical use of an indicator (4) it is expedient to specify value of resistance of loading on which stress at the antenna exit is removed.

Definition 5. the real effective square of SDCA reception is the effective area such equivalent to it on properties of the nonrandom aperture antenna of a simple geometrical design which is defined as proportionality coefficient between the power of a signal determined at the exit of the antenna and density of a stream of power of the falling radiation in the axial direction in an antenna aperture zone:

$$S_{efr} = \frac{P_{out}}{\Pi in}. \tag{5}$$

Definitions 4 and 5 allow to estimate the operating height and the effective area of reception casual antennas in the standard terminology, and for SDCA with various radio engineering loading.

Communication between the operating height and coefficient of strengthening of the spatial distributed casual antennas

For finding of analytical interrelation between the operating length and coefficient of strengthening of SDCA we use ratios (1) and (2). For this purpose we will use also known ratio

$$S_{ef} = \frac{G\lambda^2}{4\pi}, \tag{6}$$

λ- radiation wavelength;

G – antennas gain coefficient (AGC) which is connected with the strengthening coefficient (SC) through the efficiency (E):

$$g = \eta G. \tag{7}$$

The power stream density (PSD) created by the casual antenna is determined by a formula

$$\Pi = \frac{E^2}{120\pi}, \tag{8}$$

where 120 π= 377 Ohms – resistance of radiation of free space.

Power on an entrance of SDCA can be calculated on the basis of a formula

$$P = \frac{U^2}{R_{in}}, \tag{9}$$

where R_{in} – the entrance resistance of SDCA .

Substituting (8) and (9) in (2), we have:

$$S_{ef} = \frac{120\pi U_{in}{}^2}{E^2 R_{in}} \quad (10)$$

From (10) we will express entrance tension:

$$U_{in} = E\sqrt{\frac{S_{ef} R_{in}}{120\pi}} \quad (11)$$

After substitution (11) in (1) we will receive functional communication between the operating height and the effective area of the casual antenna:

$$h_e = \sqrt{\frac{S_{ef} R_{in}}{120\pi}} \quad (12)$$

Using (3) and (7), it is simple to receive required communication between the operating height and coefficient of strengthening of the casual antenna:

$$h_e = \frac{\lambda}{\pi}\sqrt{\frac{\eta g R_{in}}{480}} \quad (13)$$

The received formulas dependences allow to define the main electric characteristics of SDCA at limited basic data about casual antennas. All provided characteristics or part from them can be defined experimentally.

RESULTS

Experimental methods of characteristics definition of the spatial distributed casual antennas

As appears from the analysis of the formulas given above, definition of the major characteristics of casual antennas requires a number of basic data, thus only part from them can be defined in the settlement way, and the others demand experimental measurement. Such characteristics as SWR, the geometrical area, entrance resistance of antennas, and also intensity of the electromagnetic field created by them are most simply measured. Measurements of ESD of antennas in a wide strip of frequencies are interfaced to need of use of the expensive measuring equipment and special techniques of measurement.

We will give a technique of an experimental and settlement assessment of effective SDCA Square which is formed in measuring installation for the analysis of high-intensity microwave ovens of radiations as an example of definition of characteristics of the casual antenna (for example, RLS). Because of insufficiently high-quality shielding of the measuring receiver on an exit of the last the useful signal of the accepted and measured signal of radiation arrives not only through the calibrated measuring path (from the measuring antenna to a receiver exit), but also via the casual antenna (on power-supply circuits, grounding, switching, management, by infiltration via the screen, etc.). It is required to estimate the effective area of such SDCA . The objective can be solved as follows.

1. Disconnect the measuring antenna from an entrance of the measuring receiver. The coaxial entrance of the measuring receiver is loaded on the coordinated screened resistance.

2. In a location of the measuring receiver create the calibrated electromagnetic field with a known density of a stream of power of the Item.

3. According to the technical specification on the measuring receiver measure the power level of parasitic aiming given to an entrance of the receiver of P_p .

4. Count the equivalent effective area of the studied SDCA on a formula

$$S_{eq} = \frac{P_p}{\Pi} \quad (14)$$

If necessary correct the real effective area of the measuring antenna by subtraction from passport value of the regular measuring antenna of equivalent effective SDCA Square.

Nonlinear effects in the spatial distributed casual antennas and their influence on characteristics of antennas.

The considered parameters of casual antennas, namely the operating height, the effective area and ESD are frequency-dependent. In practice in SDCA there is a large number of nonlinear effects, especially at radiation by their signals of big power. The specified effects are shown in a wide strip of frequencies, especially at radiation of casual antennas by multi frequency signals. It has a talk that as a part of SDCA there can be elements with nonlinear electric properties (for example, oxide bimetallic contacts, transistors, diodes, chips, throttles with ferrite cores, payments with a set of elements and so forth). At radiation of SDCA nonlinear responses at frequencies of harmonicas of a signal arise a single-frequency signal (if SDCA has parametrical properties, there are radiations on sub harmonics). At radiation of casual antennas a two-frequency signal nonlinear responses are formed at combinational frequencies

$$f_k = mf_1 \pm nf_2, \quad (15)$$

where m, n – integers.

In such cases there is a need of definition of characteristics of antennas for a wide strip of frequencies at combinational frequencies that represents much more complex technical challenge. However in a number of almost important cases, for example, if the casual antenna represents the regular antenna working outside the frequency range for definition of characteristics of SDCA it is possible to use a known ratio between ESD and KU of the antenna [8, 11], mismatched with loading:

$$\sigma_{\Sigma} = \sigma_S + \sigma_a = \nu G S_g + \frac{g\lambda^2}{4\pi}\left|\frac{K_U - 1}{K_U + 1}\right|^2 . \quad (16)$$

σ_S - structural making antenna ESD;

σ_a - antenna making antenna ESD;

ν - efficiency of a surface of the antenna (PILES);

S_g - geometrical surface area of the antenna;

K_U - standing wave ratio (SWR) in an antenna path.

Passive intermodulation in the spatial distributed casual antennas

Recently in various radio engineering appendices (applied tasks), for example, at the solution of problems of ensuring electromagnetic compatibility of radio electronic facilities or problems of information security, it is necessary to consider nonlinear effects in (SDCA) [17] casual antennas. Nevertheless, so far influence of casual antennas on formation of undesirable electromagnetic radiations is investigated not rather fully. [17 - 32] methods of taking note of SDCA properties offered in scientific publications on this subject, for example, on characteristics of electromagnetic compatibility of REF don't find broad practical application yet. This results from the fact that processes of identification of SDCA , and also exact assessment of their radio engineering characteristics are extremely difficult and labor-consuming, demand high qualification from experts, and also use of the expensive special equipment. Besides, the phenomena of passive intermodulation revealed in recent years in SDCA dictate need of a quantitative assessment of influence of the SDCA nonlinear properties on parameters of electromagnetic compatibility of radio means.

Intermodulation - one of the most important reasons of incompatibility of REF. So, in communication systems of meter range falls to the share of intermodulation to 70% of cases of violation of electromagnetic compatibility of REF inadvertent hindrances. Proceeding from specified, the actual direction of development of the theory and practice of ensuring electromagnetic compatibility of REF is search of the new methods considering a contribution of casual antennas to decrease (increase) in efficiency of actions for ensuring high-quality functioning of radio means in the conditions of a difficult electromagnetic situation. There sore we will offer a method of calculation and measurement of the intermodulation radiations arising in SDCA owing to the phenomenon of passive intermodulation.

SDCA represent radiators, receptors and the lenses of the electromagnetic nature both concentrated, and distributed in space. Existence of SDCA promotes increase of level of an electromagnetic background in a zone of their placement. One of the main reasons for increase of an electromagnetic background is the phenomenon of passive intermodulation in SDCA . In most cases SDCA have obviously or implicitly expressed nonlinear and (or) parametrical properties. They can arise, for example, as a result of insufficiently dense or oxide contact in current-carrying connections "metal - metal" in SDCA design elements. The phenomenon of passive intermodulation in SDCA consists in nonlinear transformation of the sum of fluctuations of several frequencies or one signal with a continuous frequency range on the spatial distributed antenna elements with casual and weak nonlinear and parametrical properties [5]. If on any SDCA plugs two fluctuations with f1i f2 frequencies arrive , on elements of the antenna there are components with combinational frequencies where n and m – integers of a natural row 0, 1, 2, ….

If one or both fluctuations have the range other than a range of harmonious fluctuation with a strip of frequencies , the created products of intermodulation of the third order (IM 3): 2f1 – f2 and 2f2 – f1, and also IM 5: 3f1 – 2f2 and 3f2 – 2f1 have rather wide strip of frequencies and high level.

The solution of a problem of ensuring electromagnetic compatibility of REF taking into account nonlinear effects in SDCA demands receiving basic data from which the following is the major:

- a spectral panorama of the radiations generated by the casual antenna with nonlinear properties at impact on it of a multi frequency signal;

- the operating SDCA length;

- nonlinear transfer characteristic of SDCA.

It is obvious that the specified characteristics and parameters with the demanded degree of reliability can be received only in the experimental way. Techniques of removal of a panorama of electromagnetic radiations in a wide strip of frequencies are in detail described in operating instructions of analyzers of ranges of various manufacturing firms (Agilent, Hewlett – Packard , etc.).

The operating SDCA length experimentally can be removed by the technique given in GOST 8.363 – 79. It is based on creation of the calibrated electric field with known intensity E (or a magnetic field with intensity of N), measurement on clips of the reception studied antenna induced by this field electromotive force e and calculation of the operating antenna length on a formula

$$\sigma_{\Sigma} = \sigma_S + \sigma_a = \nu G S_g + \frac{g\lambda^2}{4\pi}\left|\frac{K_U - 1}{K_U + 1}\right|^2 . \quad (17)$$

where - the wave resistance of free space;

e – induced in the antenna electromotive force (EMF), V;

E – the created calibrated electric field, V/m;

N – the created calibrated magnetic field, A/m.

It should be noted that simple measuring procedure on the basis of (14) corresponds to the determination of the operating height (length) of SDCA entered above.

Measuring installation for determination of the operating length of SDCA has to turn on the voltmeter for measurement induced in the antenna EMF, and also the generator of standard signals with the calibrated exit and the calibrated measuring antenna, applied to creation of the calibrated electric or magnetic field. The exit of the generator of standard signals is connected to an entrance of the measuring antenna.

SDCA remove the nonlinear static characteristic transfer (through passage) by a standard technique of definition of the amplitude transfer characteristic of object (two-port network) with nonlinear electric properties. For this purpose give tension of U_{in} increasing with the set step on the SDCA entrance plugs and remove corresponding values of amplitudes of tension of U_{out} from output plugs. The transfer characteristic is built in the form of the schedule of dependence

$$\sigma_{\Sigma} = \sigma_S + \sigma_a = \nu G S_g + \frac{g\lambda^2}{4\pi}\left|\frac{K_U -1}{K_U +1}\right|^2 . \qquad (18)$$

After receiving basic data it is possible to calculate frequencies and levels of the products of intermodulation of the second, third and fifth order (having the greatest amplitude).

Intermodulation products (IP) of the specified orders are defined simply:

IP 2:f2 – f1 and f2 + f1;

IP 3: 2f1 – f2 and 2f2 – f1;

IP 5: 3f1 – 2f2 and 3f2 – 2f1 .

Amplitudes of products of intermodulation define experimentally or count by the following technique.

By results of the nonlinear static transfer characteristic of SDCA set in basic data the last is approximated power series:

$$Y(X) = G_1 X + G_2 X^2 + G_3 X^3 + \ldots, \qquad (19)$$

X-amplitude of a signal on SDCA entrance, and Y– at its exit.

Being limited to the third degree of a polynom (16) and selecting dimensionless coefficients of G1, G2 and G3 (they can be fractional and negative) by means of the standard mathematical approximating packages, with rather high precision it is possible to approximate a type of the removed experimentally transfer characteristic of SDCA .

When giving on an entrance of SDCA of a two-frequency un-modulated signal from generators of signals with amplitudes A and B (or at radiation of SDCA a two-frequency signal) (figure 2) the entrance signal is described by simple function:

$$X = A\sin a + B\sin b, \qquad (20)$$

$\alpha = 2\pi f_1 t, \beta = 2\pi f_2 t$ – circular frequencies of harmonious signals.

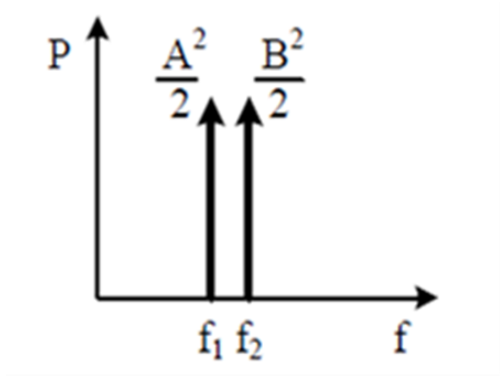

Figure 2: Entrance signal

Amplitudes of products of intermodulation of the second and third orders at the exit of a nonlinear path are defined by parameters $X^2 = (A\sin\alpha + B\sin\beta)^2$ и

$$X^3 = (A\sin\alpha + B\sin\beta)^3.$$

As a result of not difficult trigonometrical transformations values of these amplitudes are received:

$$\begin{aligned}(A\sin a + B\sin b)^2 &= \frac{A^2+B^2}{2} - \\ &- AB\cos(\alpha+\beta) + AB\cos(\alpha-\beta) - \\ &- \frac{A^2}{2}\cos 2\alpha - \frac{B^2}{2}\cos 2\beta,\end{aligned} \qquad (21)$$

$$\begin{aligned}(A\sin\alpha + B\sin\beta)^3 &= \left(\frac{3}{4}A^3 + \frac{3}{2}B^2 A\right)\sin\alpha + \\ &+ \left(\frac{3}{4}B^3 + \frac{3}{2}A^2 B\right)\sin\beta + \\ &+ \frac{3}{4}A^2 B\sin(2\alpha-\beta) + \frac{3}{4}B^2 A\sin(2\beta-\alpha) - \\ &- \frac{A^3}{4}\sin 3\alpha - \frac{B^3}{4}\sin 3\beta - \\ &- \frac{3}{4}A^2 B\sin(2\alpha+\beta) - \frac{3}{4}B^2 A\sin(2\beta+\alpha)\end{aligned} \qquad (22)$$

By substitution (20) and (21) in (22) taking into account that capacities of entrance signals at frequencies f_1 and f_2 are defined by their amplitudes by ratios $P_A = \frac{A^2}{2}, P_B = \frac{B^2}{2}$,calculated values of capacities of intermodulation components of the second and third orders at the exit of SDCA which are specified in figure 3 are received. Expression for IM5 is bulky and for this reason isn't given.

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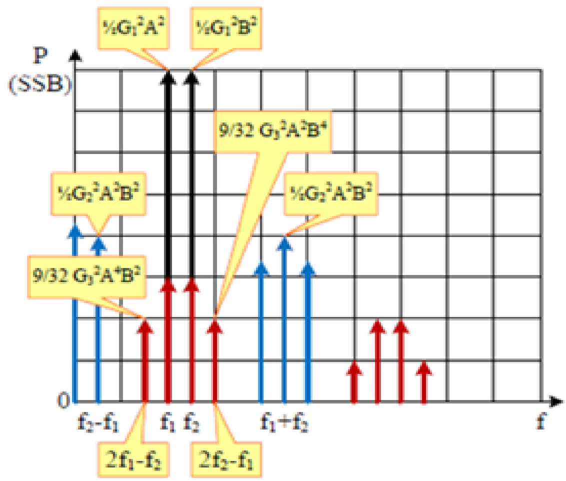

Figure 3: Amplitudes of intermodulation components

DISCUSSION

The stated simple technique allows to make the preliminary express analysis of possible intermodulation products in SDCA and to reveal the most preserable on the greatest levels of capacities in the settlement way. Application of this technique allows to reduce the total amount of the subsequent measurements, limiting only to their detailed research of the most considerable on power level of the generated intermodulation influences.

After determination of amplitudes of intermodulation products at SDCA exit, using basic data about operating SDCA length, it is possible to calculate intensity of a field of the corresponding radiations of SDCA at the set distance.

In the point located at some corresponding distance from SDCA , intensity of a field of radiation of the intermodulation masking hindrances can be calculated according to recommendations of MSE – R P . 525 – 2 on a formula:

$$E_c = \frac{30\sqrt{p_a}}{R}, \qquad (23)$$

where:

E_c: mean square value of intensity of a field (In oil);

p_a: the radiated SDCA power in the direction of the considered point (W);

R: distance from the transmitter to the considered point (m).

Recently there was a special equipment facilitating an assessment of nonlinear characteristics of objects sources of passive intermodulation (PIM).

The equipment for passive intermodulation testing in the spatial distributed casual antennas.

The specialized equipment for testing of chains, devices and systems on determination of the PIM level is made by firms Kaelus, Agilent, Rosenberger, Wireless Telecom Group, AWT Global, Anritsu , etc.

Kaelus firm (division of the Smiths Interconnect company) – the successor of the famous producer of the equipment for testing of PIM-parameters of the cellular Summitek Instruments networks. Devices are equipped with the built-in modes of monitoring of a range, swing of frequency and tracking of change of PIM on time at dynamic testing according to the IEC 62037 standard. Their PIM own level no more than-168 dBW at the test 2 … 20 W. Sensitivity of the receiver allows to measure PIM-components with power level from –50 to –128 dBmW. Input power of two test sources is established in the range from 20 to 43 dBmW with a step by 1 dB. IM-components of the third, fifth, optionally the seventh and ninth orders are controlled. The mass of a tester of iTA makes 22 kg, crash-worthiness 40 G, the device functions from the built-in batteries to 2 h at a temperature from-10 to 45 °C.

The laboratory analyzer of the S1L series of the AWT Global company (figure 3) is intended for diagnostics of the PIM-phenomena at frequencies from 730 to 2690 MHz. Sensitivity to PIM-components in the S1L analyzer makes –172 dBW at the test 2. 43 dBmW; power of sources of test signals is established ranging from 15 to 46 dBmW.

The device allows to measure from IM3 to IM25 components; has the dynamic range of levels not less than 96 dB; provides documenting of results; it is equipped with the modes of measurement of distance to a source of nonlinearity (Distance-to-PIM). The device is completed with the cables coordinated by loadings, connectors and adapters with the PIM small level, a test source of the distorted PIMGEN signals with the PIM level to –80 dBmW.

Figure 4:– PIM device analyzer of the AWT Glob-

The tester of MW82119A of the PIM Master series of the Anritsu company (risunok.4), differs in high precision of measurements and is equipped with the Distance-to-PIM modes for definition of a distance to a nonlinearity source.

Figure 5:- MW82119A tester

Measuring instruments of passive modulation allow to simplify significantly difficult measuring procedures for the analysis of intermodulation hindrances by means of the offered tool calculation method.

CONCLUSION

Lack of obviously expressed radio engineering loading, difference of conditions of generation and reception of electromagnetic signals and hindrances in SDCA and other specific features of casual antennas dictate need of search of reliable methods of an assessment of their parameters and characteristics for a wide strip of frequencies. In article in the production plan some possible methodical approaches to definition of the major characteristics of SDCA are determined by calculation and experimental methods. In our opinion, the following results are the most important: the new classification indicator for an assessment of the prevailing properties of the casual antenna (3) is entered, ratios between the operating height and coefficient of strengthening of receptions and the transferring SDCA are received, the simple experimental technique of determination of the effective area of the casual antenna is offered, possibility of useful application of SDCA with nonlinear electric properties for masking of channels of leakage of audio information on an electromagnetic field is proved.

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