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Direction finding characteristic of an “antenna – radome” system and ways of increasing direction finding accuracy for radiolocation objects

In the work we provide a theoretical verification for various techniques of increasing direction finding accuracy of on-board radio systems equipped with “antenna – radome” systems, based on representing a direction finding characteristic of an “antenna – radome” system as a power series. Moreover, we describe design principles and flowcharts of direction finders ensuring a multiple increase in detection accuracy. Consequently, we analyse direction finding errors, and supply our research with the results of investigating a device implementing the techniques suggested.

Keywords: direction finding accuracy, direction finding antenna, radome, antenna – radome system, on-board radio system.

Introduction

As the speed, manoeuvrability and altitude capacity of radiolocation objects increase, it is important to improve the accuracy of direction finding using radars comprising a system that consists of a direction finding antenna and a radiotransparent radome protecting it from environment. A real world’s antenna – radome (A–R) system is known to have various distortions of the direction finding antenna’s directivity characteristics that depend on its angular position relative to the radome. Such distortions result in direction finding errors (DFE), which lead to target direction finding in the apparent direction instead of the true one [1].

Traditionally, in radiolocation, irrespective of a direction finding method (phase or amplitude method), the direction finding characteristic (DFC) is approximated by the linear function of the angle of deviation of an object, the direction of which is to be found, from the optical axis of the antenna. This characteristic is defined by the single parameter – the DFC slope, while the angular position of a reflected signal source is determined as a quotient of the direction finding receiver output voltage divided by the DFC slope.

While passing through the radiotransparent radome, the front of electromagnetic wave is exposed to local distortion. DFC parameters depend on frequency, angular position of the antenna relative to the radome, polarization characteristics of the electromagnetic field, temperature conditions, etc. In such conditions, it is impossible to solve a large amount of radiolocation problems without detailed knowledge of the DFC, which cannot be described by the single parameter, the DFC slope, anymore.

Direction finding characteristic of the radome antenna

The electromagnetic field reflected from the object and incident to the A–R system is a quasi-plane wave [2] with its polarization ellipse parameters being the main axis orientation angle $\gamma_{эл}$ and ellipticity ratio $K_{эл}$ (Fig.1) that may vary depending on radiation wave parameters and the object angle relative to the radar.

Below we will analyse the A–R system’s DFC: $P_{А–О}\{\beta,[\alpha_x, \alpha_y(\gamma_{эл}, K_{эл})]\}$ for angular position α_x, α_y of the direction finding antenna relative to the radome. As a rule, the DFC is represented in the form of a near-linear dependence of direction finding receiver output voltage $P_{А–О}\{\beta,[...]\}$ on the radiolocation object’s angular position β in the direction finding plane. The DFC is normalized by dividing it by scale coefficient C_{M1A} expressed in volts/degrees and corresponding to the DFC slope without radome for $\alpha_x = \alpha_y = 0$.

A detailed analysis of physical phenomena resulting in distortions of directivity characteristics in the A–R system [1, 3–5] makes is possible to present normalized DFC $\beta_{А–О}\{\beta,[\alpha_x, \alpha_y(\gamma_{эл}, K_{эл})]\}$ of the A–R system for each direction finding channel (Fig. 2) in a generalised form

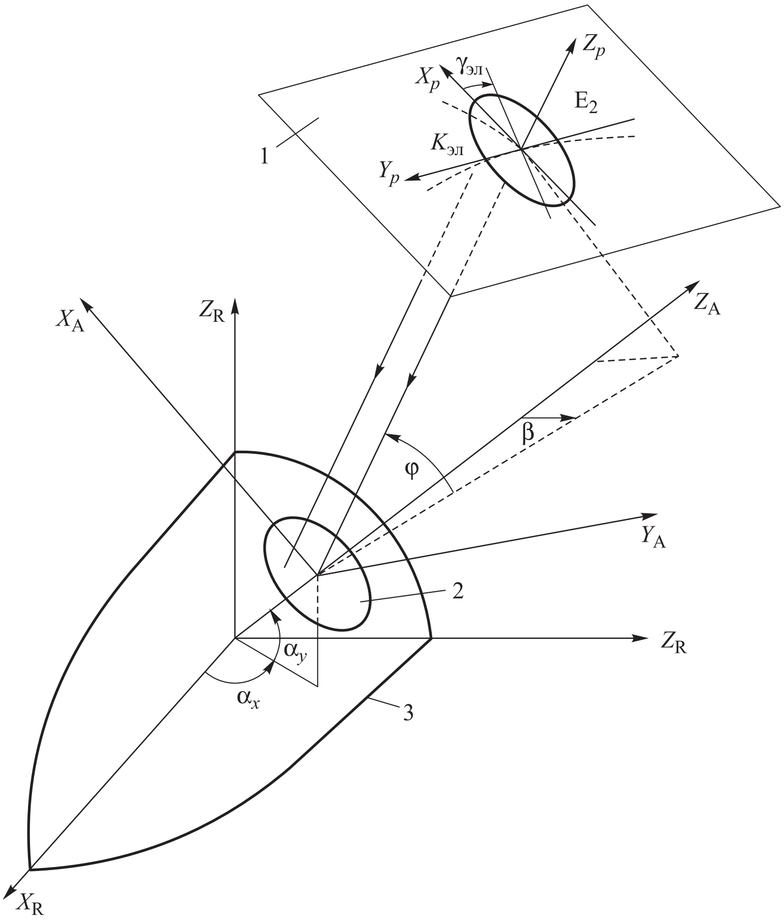

Fig. 1. Incidence of a reflected electromagnetic wave onto the A–R system:
1 – incident wave front plane; 2 – antenna aperture;
3 – radome

$$\begin{aligned}
&\beta_{\text{A–O}}\left\{\beta,\left[\alpha_x,\alpha_y(\gamma_{\text{эл}},K_{\text{эл}})\right]\right\}=\\
&=C_{0\text{A–O}}\left[\alpha_x,\alpha_y(\gamma_{\text{эл}},K_{\text{эл}})\right]+\\
&+C_{1\text{A–O}}\left[\alpha_x,\alpha_y(\gamma_{\text{эл}},K_{\text{эл}})\right]\beta+\\
&+C_{2\text{A–O}}\left[\alpha_x,\alpha_y(\gamma_{\text{эл}},K_{\text{эл}})\right]\beta^2+\\
&+C_{3\text{A–O}}\left[\alpha_x,\alpha_y(\gamma_{\text{эл}},K_{\text{эл}})\right]\beta^3+\ldots, \qquad (1)
\end{aligned}$$

where $\beta_{\text{A–O}}\{\ldots\}$ – angular deviation of the radiolocation object at the direction finding receiver output measured by the A–R system; the series coefficients characterize the following:

$C_{0\,\text{A–O}}[\ldots]$ – A–R system’s DFC zero offset;

$C_{1\text{A–O}}[\ldots]$ – A–R system’s normalized DFC slope;

$C_{2\,\text{A–O}}[\ldots]$, $C_{3\,\text{A–O}}[\ldots]$, ... , – distortions of the second and higher orders.

Without a radome, the linear section of the antenna DFC has the following parameters: $C_{0\,\text{A–O}}[\ldots]=0$, $C_{2\,\text{A–O}}[\ldots]=0$, $C_{3\,\text{A–O}}[\ldots]=0$, ... and the DFC has the following form

$$\begin{aligned}
&\beta_{\text{A}}\left\{\beta,\left[\alpha_x,\alpha_y(\gamma_{\text{эл}},K_{\text{эл}})\right]\right\}=\\
&=C_{1\text{A}}\left[\alpha_x,\alpha_y(\gamma_{\text{эл}},K_{\text{эл}})\right]\beta, \qquad (2)
\end{aligned}$$

where $C_{1\text{A}}[\ldots]$ – slope of normalized antenna DFC without radome for $\alpha_x=\alpha_y=0$. Usually, $C_{1\text{A}}[\ldots]=1$.

As a rule, due to electromagnetic wave amplitude-phase distortions introduced by radome walls, $|C_{1\,\text{A–O}}[\ldots]|<|C_{1\text{A}}[\ldots]|$.

According to equation (2), the transfer characteristic of the A–R system as a direction finding channel transducer (Fig. 3), with no radome

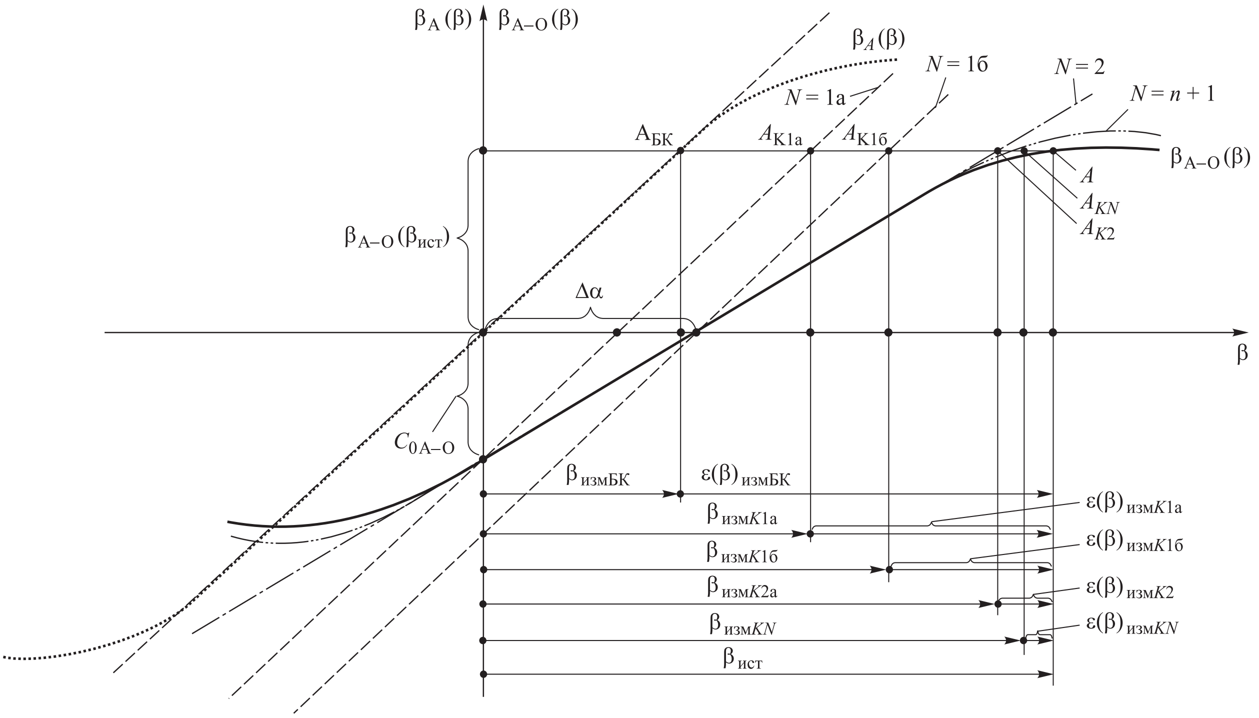

Fig. 2. Direction finding characteristics of the A–R system before and after correction

installed, can be represented in the form of a section with transfer coefficient

$$\frac{\beta_{\text{A}}\left\{\beta=\beta_{\text{ист}},\left[\alpha_x,\alpha_y(\gamma_{\text{эл}},K_{\text{эл}})\right]\right\}}{C_{1\text{A}}\left[\alpha_x,\alpha_y(\gamma_{\text{эл}},K_{\text{эл}})\right]},$$

where $\beta_{\text{ист}}$ – true angular position of the object relative to the antenna's coordinate system;
$\beta_{\text{изм}}$ – measured angular position of the object relative to the antenna's coordinate system.

Usually, the value of coefficient $C_{\text{M 1 A}}[...]$ is determined experimentally during preliminary calibration of the A–R system and uploaded to an on-board computer data storage (DS) (see Fig. 3, a). It is obvious that without a radome and respective distortions introduced, equation $\beta_{\text{изм}}=\beta_{\text{ист}}$ is true.

As a rule, expression (2) used to be fundamental for direction finding and tracking systems in radiolocation. The expression was supposed to be true for systems comprising a direction finding antenna and a radome.

The A–R system's direction finding error $\Delta\alpha$ for $\beta=\Delta\alpha$ can be determined based on expression (1) from condition $\beta_{\text{A–O}}\{\beta=\Delta\alpha,[\alpha_x,\alpha_y(\gamma_{\text{эл}},K_{\text{эл}})]\}=0$.

Consequently, if the A–R system is equipped with a radome and the radiolocation object is oriented in the direction $\beta=\beta_{\text{ист}}$, the target angular deviation recorded at the direction finding receiver (see Fig. 2), will be equal not to $\beta_{\text{A}}\{\beta=\beta_{\text{ист}},[...]\}$, but to $\beta_{\text{A–O}}\{\beta=\beta_{\text{ист}},[...]\}$.

Let us formulate the problem of direction finding accuracy enhancement in the A–R system in a general form. As noted above, the DFC is the function of angular position of the direction finding antenna in radome α_x, α_y and depends on many parameters: parameters of radiation wave polarization ellipse $\gamma_{\text{эл}}$, $K_{\text{эл}}$, probing pulse radiation frequency f, A–R system in-flight heating temperature T, time elapsed after tracking start, etc. [1]. That is why, the direction finding accuracy enhancement problem statement is correct only upon fixing these parameters or, at least, if we assume that variation in parameters will not lead to significant distortions of the DFC. Such an assumption is important regarding the accuracy of radiolocation direction finding. Experience has proven that such an assumption is acceptable for a standard on-board radar where the same direction finding antenna is responsible for radiation of probing pulses and reception of reflected signals.

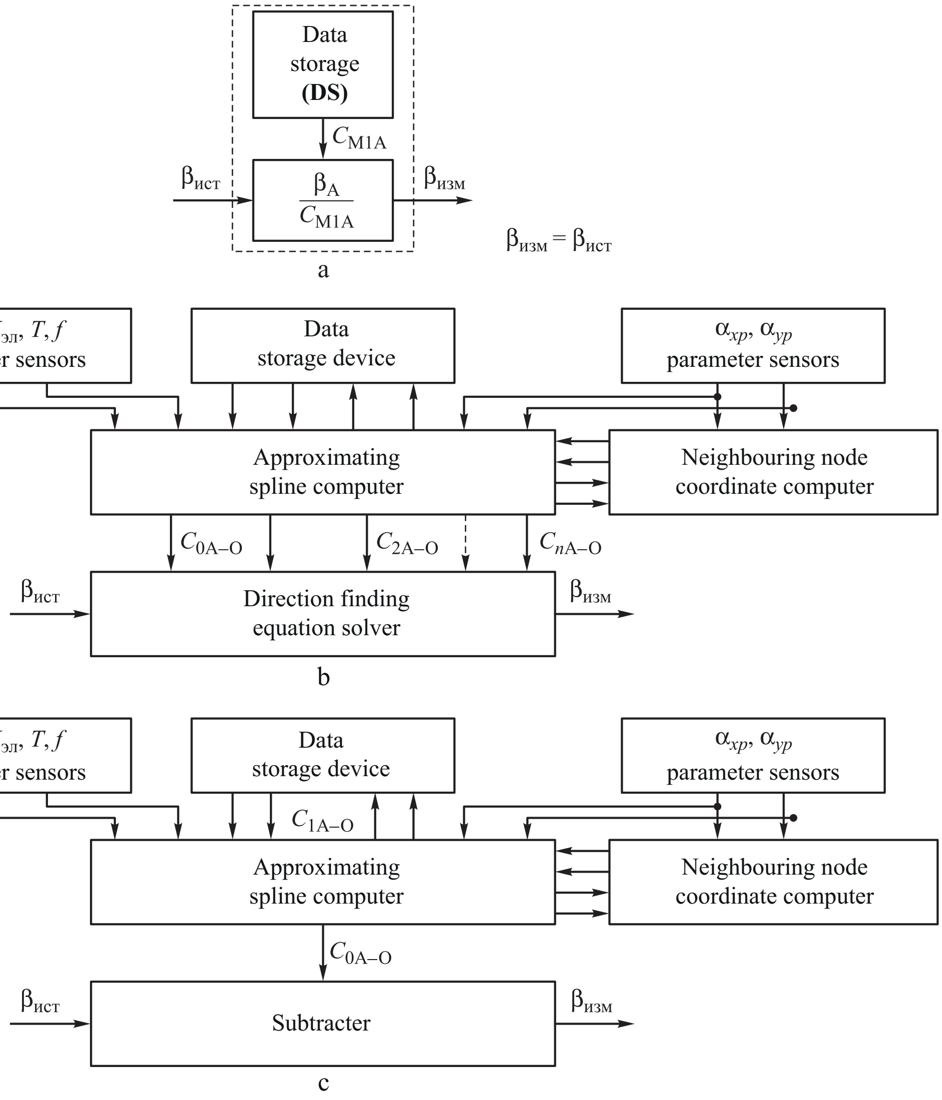

Fig. 3. Block diagrams of direction finders of different order:
a – without radome; b – N-th order direction finder; c – 1st order direction finder

It is obvious that at the first stage of solving the problem of the A–R system direction finding accuracy enhancement, it is necessary to theoretically and experimentally determine functional dependences between DFC distortions, in particular, between DFC expansion coefficients and the angular positions of the direction finding antenna α_x, α_y.

Actually, problem solving can be narrowed down to theoretical or experimental determination of DFC expansion coefficient values ($N = n + 1$, where n is the order of polynomial used for DFC expansion) and uploading them to the data storage. The amount of expansion coefficients N shown below is selected according to the requirements for direction finding error.

At the second stage, it is necessary to establish analytical relationships between true $\beta_{ист}$ and measured $\beta_{изм}$ and between angular positions of the radiolocation objects, which allow to find directions to the radiolocation object with the required direction finding error $\varepsilon(\beta) = \beta_{изм} - \beta_{ист}$.

Finally, at the third stage of solving the problem of direction finding accuracy enhancement, it is necessary to calculate value $\beta_{изм}$ that provides the required direction finding accuracy with account for a limited memory volume of the data storage available to the developer. It is necessary to use the results obtained during operation at the first and second stages.

Based on expression (1), the above considerations make it possible to synthesize the signal processing algorithm in a general form, which comes down to determination of $\beta_{изм}$ as the root of the direction finding equation

$$\begin{aligned}
&\beta_{\text{A-O}}\left\{\beta=\beta_{ист},\left[\alpha_x,\alpha_y(\gamma_{эл},K_{эл})\right]\right\}-\\
&-C_{0\text{A-O}}\left[\alpha_x,\alpha_y(\gamma_{эл},K_{эл})\right]-\\
&-C_{1\text{A-O}}\left[\alpha_x,\alpha_y(\gamma_{эл},K_{эл})\right]\beta_{изм}-\\
&-C_{2\text{A-O}}\left[\alpha_x,\alpha_y(\gamma_{эл},K_{эл})\right]\beta^2_{изм}-\\
&-C_{3\text{A-O}}\left[\alpha_x,\alpha_y(\gamma_{эл},K_{эл})\right]\beta^3_{изм}-\ldots-\\
&-C_{n\text{A-O}}\left[\alpha_x,\alpha_y(\gamma_{эл},K_{эл})\right]\beta^n_{изм}=0. \qquad (3)
\end{aligned}$$

Note that in a particular case with the antenna not equipped with a radome, when $C_{0\,\text{A–O}}[\ldots]=0$, $C_{2\,\text{A–O}}[\ldots]=0$, $C_{3\,\text{A–O}}[\ldots]=0$, ..., $C_{n\,\text{A–O}}[\ldots]=0$, the direction finding equation (3) comes down to the standard form (2) in its linear section. It is obvious that at $n\rightarrow\infty$, $\varepsilon(\beta)\rightarrow 0$ there is a theoretical possibility to develop an ideal direction finder with the A–R system, which has $\beta_{изм}=\beta_{ист}$. However, the number of members in equation (3) is actually limited to value N, which is conventionally referred to as the order of direction finder.

Functioning of the direction finder of the N-th order (Fig. 3, b) that we describe in patent [3], synthesized on the basis of implementation of the above algorithms, can be explained as follows. While functioning, the radar continuously solves direction finding equation (3). For values α_x, α_y measured at direction finding transducers outputs, the computer extracts values $C_{0\,\text{A–O}}$, $C_{1\,\text{A–O}}$, ..., $C_{n\,\text{A–O}}$, from the data storage device, corresponding to current values of direction finding parameters α_x, α_y; $\gamma_{эл}$, $K_{эл}$; T, f... . Using this data along with the direction finder output signal indicating angular deviation of a target $\beta_{\text{A–O}}\{\beta=\beta_{ист},[\alpha_x,\alpha_y(\gamma_{эл},K_{эл})]\}$ allows to solve equation (3) while solving the direction finding equation.

Generally, since the DFC is set by the polynomial of the n-th order, solving this direction finding problem gives n of root values including complex numbers. To solve direction finding problems, the most important parameters are those being in the domain of quasilinearity and unambiguity; that is why due to physical considerations the real root with a minimum amplitude value will correspond to $\beta_{изм}$.

In ground test conditions, experimental measurement and calculation of DFC coefficient values in direction finding equation (3) with variable parameters α_x, α_y and fixed parameters $\gamma_{эл}$, $K_{эл}$ are described in detail in [4–6]; therefore, the DFC function can be set with any required accuracy. Measured values of coefficients $C_{0\,\text{A–O}}$, $C_{1\,\text{A–O}}$, $C_{2\,\text{A–O}}$, ..., $C_{n\,\text{A–O}}$ are uploaded to the data storage device (see Fig. 3, b).

Experimental measurement of these coefficients and storage of relevant large volumes of information on an on-board computer for different parameter values requires solving of complex technical problems associated with development of automated measuring complexes, multi-stage rotary devices, data storage devices with a large memory space, etc. The required direction finder order N can be reasonably selected by solving the optimization problem, i.e. by satisfying controversial requirements to the accuracy of direction finding and to the non-volatile memory space in the data storage device available to the developer.

Synthesis and analysis of direction finding accuracy enhancement algorithms

Let us proceed with the synthesis and analysis of direction finding algorithms for particular cases derived from direction finding equation (3).

For the 1st order direction finder ($N=1$), data on the value of only one DFC parameter of the A–R system are used. Herewith, we can say there are two variants for implementing the 1st order direction finder (Fig. 3, a, b).

In the first variant (see Fig. 3, variant a), data on the value of coefficient $C_{0\,\text{A–O}}[\ldots]$ are used and the following assumptions are made: $C_{1\,\text{A–O}}[\ldots]=$ $=C_{1\,\text{A}}[\ldots]$; $C_{i\text{A–O}}[\ldots]=0$, where $i\geq 2$. In this case, the processing algorithm as per direction finding equation (3) will have the following form:

$$\beta_{изм}=\frac{\beta_{\text{A-O}}\{\beta=\beta_{ист},[\ldots]\}}{C_{1\text{A}}}-\frac{C_{0\text{A-O}}}{C_{1\text{A}}}. \qquad (4)$$

The DFC for this case is shown in Fig. 2, the block diagram of the 1st order direction finder is shown in Fig. 3, c. It is easy to demonstrate that with assumptions made, the value of absolute direction finding error is

$$\varepsilon(\beta) = \beta_{\text{изм}} - \beta_{\text{ист}} = -\Delta\alpha = \frac{C_{0\text{A–O}}}{C_{1\text{A}}}.$$

In this case, expression (4) can be represented in the following form

$$\beta_{\text{изм}} = \frac{\beta_{\text{A–O}}\{\beta = \beta_{\text{ист}},[\ldots]\}}{C_{1\text{A}}} - \frac{C_{0\text{A–O}}}{C_{1\text{A}}} = \\ = \frac{\beta_{\text{A–O}}\{\beta = E_{\text{ист}},[\ldots]\}}{C_{1\text{A}}} - \varepsilon(\beta). \quad (5)$$

According to (5), the 1st order direction finder is a device described in [7]. It is more convenient to analyse the second variant of the 1st order direction finder (see Fig. 3, b) after analysing the 2nd order direction finder.

For the 2nd order direction finder for all $i \geq 2$, it is assumed that $C_{i\text{A–O}}[\ldots] = 0$ and data on values of two coefficients $C_{0\,\text{A–O}}[\ldots]$, $C_{1\,\text{A–O}}[\ldots]$ are used.

For this case, we derive the following expression from (3)

$$\beta_{\text{изм}} = \frac{\beta_{\text{A–O}}\{\beta = \beta_{\text{ист}},[\ldots]\}}{C_{1\text{A–O}}} - \frac{C_{0\text{A–O}}}{C_{1\text{A–O}}}. \quad (6)$$

Note that for the assumptions made above

$$\varepsilon(\beta) = \beta_{\text{изм}} = \beta_{\text{ист}} = -\Delta\alpha = \frac{C_{0\text{A–O}}}{C_{1\text{A–O}}},$$

where $\Delta\alpha$ – A–R system’s DFC zero offset.

$\Delta A\alpha$ can be accurately measured by applying the moving-source method [8] or using the devices (described in the previous publications [4–6]) that allow to measure values of $C_{1\,\text{A–O}}[\ldots]$ as well.

Back to the 1st order direction finder, the algorithm of the 1st order direction finder ($N = 1$) of the second variant can be synthesized from equation (6), if $C_{1\,\text{A–O}}$ is substituted for coefficient $C_{1\text{A}}$ in the denominator of the first term of the equation. In this case, the algorithm for processing signals of the 1st order direction finder ($N = 1$) as per variant b is represented in the following form

$$\beta_{\text{изм}} = \frac{\beta_{\text{A–O}}\{\beta = \beta_{\text{ист}},[\ldots]\}}{C_{1\text{A}}} - \frac{C_{0\text{A–O}}}{C_{1\text{A–O}}}. \quad (7)$$

Using the proposed method, we can synthesize block diagrams of direction finders of the 3rd or higher order.

Fig. 2 illustrates signal processing algorithms for direction finders of different orders. Point A corresponds to a signal from the radiolocation object oriented in the direction $\beta_{\text{ист}}$ towards the normalized DFC of system A–O $\beta_{\text{A–O}}(\beta)$. Point A_{KN} corresponds to a signal on the corrected DFC of the N-th order direction finder; point A_{K2} corresponds to the 2nd order direction finder; point $A_{K1\text{a}}$ – to the 1st order direction finder; point $A_{K1\text{б}}$ – to the 1st order direction finder of variant b; point $A_{БK}$ – to the DFC of the A–R system without correction. The figure also illustrates reduction of absolute direction finding errors $\varepsilon(\beta)_{\text{изм}KN}$ as direction finder order N grows.

Comparative analysis of the accuracy of direction finders of different order

Procedural errors of direction finders can be analysed by means of theoretical calculation or experimental measurement of the DFC of real A–R systems. For different values of parameters α_x, α_y DFC data is approximated by polynomials of different degrees (for example, using the least-square method), and values of coefficients $C_{0\,\text{A–O}}$, $C_{1\,\text{A–O}}$, $C_{2\,\text{A–O}}$, …, $C_{n\,\text{A–O}}$ are determined. By subtracting direction finding equation (3) for fixed value n from the direction finding equation for the case of ideal direction finder at $n \to \infty$, when $\beta_{\text{изм}} = \beta_{\text{ист}}$, after some transformations and simplifications, we have the following expression for relative procedural error of direction finding $\delta_K = [(\beta_{\text{изм}} - \beta_{\text{ист}})/\beta_{\text{ист}}] \cdot 100\,\%$:

$$\delta_{KN} = \\ = \left[\frac{C_{n+1}\beta^{n}_{\text{ист}} + C_{n+2}\beta^{n+1}_{\text{ист}} + C_{n+3}\beta^{n+2}_{\text{ист}} + \ldots}{C_{1\text{A–O}} + 2C_{2\text{A–O}}\beta_{\text{ист}} + 3C_{3\text{A–O}}\beta^{2}_{\text{ист}} + \ldots}\right] \times \\ \times 100\,\%. \quad (8)$$

Expression (8) allows to estimate in a general form the relative procedural error of direction finding for given value $n \geq 1$. Herewith, values of coefficients $C_{0\,A\text{–}O}$, $C_{1\,A\text{–}O}$, $C_{2\,A\text{–}O}$, ... can be calculated or determined experimentally (Table 1). Note that absolute values of DFC expansion coefficients quickly decrease as the coefficient order grows in the A–R system as well as in the system without a radome. In this case, the DFC is a nearly linear function.

Let us estimate direction finding procedural errors δ_K for different practical cases with account for their specific features. After transformations similar to those applied in order to derive analytical ratio (8), we have the following expression for the 1st order direction finder (see Fig. 3, a)

$$\delta_{K1a} = \left[\left(\frac{C_{1\text{A–O}} - C_{1\text{A}}}{C_{1\text{A}}}\right) \times \right. \tag{9}$$

$$\left. \times\, C_{2\text{A–O}}\beta_{\text{ист}} + C_{3\text{A–O}}\beta^2_{\text{ист}} + \ldots\right] \cdot 100\,\%.$$

According to expression (9), the procedural error of the 1st order direction finder (variant a) is defined by the value of coefficient $C_{1\,\text{A–O}}$, while the contribution to the total procedural error of components caused by distortions of the DFC of the 2nd and higher orders depends on angular position $\beta_{\text{ист}}$ of the object, whose direction is to be found. According to theoretical and experimental studies of typical A–R systems for different positions of the antenna relative to the radome, the value of $C_{1\text{A–O}}$ may vary from 0.7 to 1.1. If a contribution made by distortions of the DFC of the 2nd or higher order is ignored, the expected procedural error of the 1st order direction finder will be $\beta_{K1a} = -30\,\% \ldots +10\,\%$.

For the particular case of the 1st direction finder, we have the following expression by applying transformations similar to those applied for deriving ratios (8) and (9)

$$\delta_{K1б} = \left[\left(\frac{C_{1\text{A–O}} - C_{1\text{A}}}{C_{1\text{A}}}\right)\left(1 - \frac{\Delta\alpha}{\beta_{\text{ист}}}\right) + \right.$$

$$\left. + C_{2\text{A–O}}\beta_{\text{ист}} + C_{3\text{A–O}}E^2_{\text{ист}} + \ldots\right] \cdot 100\,\%. \tag{10}$$

For the particular case of the 2nd direction finder, the following expression for procedural error is derived from equation (8):

$$\delta_{K2} = \left[\frac{C_2\beta_{\text{ист}} + C_3\beta^2_{\text{ист}} + C_4\beta^3_{\text{ист}} + \ldots}{C_{1\text{A–O}} + 2C_{2\text{A–O}}\beta_{\text{ист}} + 3C_{3\text{A–O}}\beta^2_{\text{ист}} + \ldots}\right] \times$$

$$\times\, 100\,\%.$$

Therefore, the value of measurement method error of the 2nd order direction finder is defined only by distortions of the DFC of the 2nd or higher order and depends on the direction finding object’s angular position $\beta_{\text{ист}}$.

To verify the reliability of obtained theoretical findings, we conducted experimental studies

Table 1

Coefficient values determined as a result of experimental study of a typical “antenna – radome” system

In “antenna – radome” system						
α, deg	$C_{0\text{A–O}}$	$C_{1\text{A–O}}$	$C_{2\text{A–O}}$	$C_{3\text{A–O}}$	$C_{4\text{A–O}}$	$C_{5\text{A–O}}$
0	0.0021	1.0062	1.1606e-004	1.8915e-007	–7.3652e-008	2.3714e-009
8	4.1970	1.0210	2.3825e-004	1.1494e-005	1.2610e-007	2.4328e-009
12	6.4113	0.9298	5.9145e-004	2.5388e-005	–2.7787e-007	–1.7799e-008
Without radome						
α, deg	$C_{0\text{A}}$	$C_{1\text{A}}$	$C_{2\text{A}}$	$C_{3\text{A}}$	$C_{4\text{A}}$	$C_{5\text{A}}$
0	–0.0016	1	8.5370e-005	3.3478e-006	–1.7632e-008	1.7911e-009

of the accuracy of direction finding while implementing the proposed signal processing algorithms. As an example, Fig. 4 illustrates the results of measurement of direction finding errors in the A–R system before correction as part of the standard-type direction finder and after correction as part of the 1st order direction finder of variant a. It is noticeable that even application of the direction finder of the 1st order allows to reduce maximum values of DFE by 4–5 times. This proves the reliability of theoretical findings, as well as design circuit solutions developed with their help. Some solutions are patented and field-tested.

Conclusions

The completed theoretical analysis allows to revise a traditional assumption about the direction finding characteristic of a standard-type radar and generalize it for a system comprising a direction finding antenna and a radiotransparent radome. This allows to solve the problem of enhancing the accuracy of direction finding and tracking by synthesizing signal processing algorithms and block diagrams of direction finders of the 1st, 2nd or higher order that virtually make it possible to eliminate direction finding errors caused by distortions of electromagnetic waves in the A–R system.

Resulting analytical ratios and developed methods allow to estimate procedural errors of different signal processing algorithms and to apply a reasonable approach to the synthesis of an optimal direction finder depending on the set requirements.

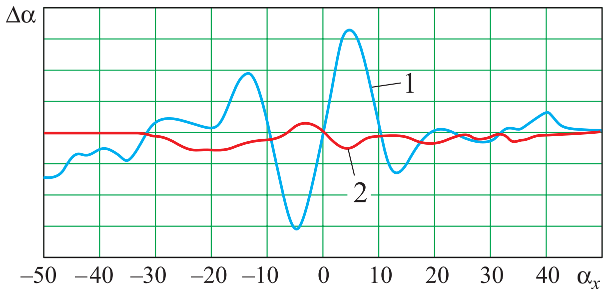

Fig. 4. Direction finding errors of the system:
1 – standard direction finder; 2 – 1st-order direction finder

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Research interests: development and radio engineering trials of antenna – radome systems.

Пеленгационная характеристика системы «антенна – обтекатель» и пути повышения точности пеленгации радиолокационных объектов

На основе представления степенным рядом пеленгационной характеристики системы «антенна – обтекатель» дано теоретическое обоснование различных методов повышения точности пеленгации оснащенных данными системами бортовых радиолокационных станций (РЛС). Изложены принципы построения и приведены блок-схемы пеленгаторов, обеспечивающих многократное повышение точности визирования. Проанализированы ошибки пеленгации и приведены результаты исследования аппарата, реализующего предлагаемые методы.

Ключевые слова: точность пеленгации, пеленгационная антенна, радиопрозрачный обтекатель, система «антенна – обтекатель», бортовая РЛС.

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