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Metrological Characteristics of Antenna System for Measuring Electromagnetic Field Parameters

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Abstract—Errors in measuring the electromagnetic field parameters of a five-element antenna system have been analyzed. Analytical relationships for main errors were derived, and maximum values of measurement errors were calculated.

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INTRODUCTION

A general-purpose measuring antenna system was developed for radiomonitoring of electromagnetic situation, radio control of electromagnetic radiations, research and analysis of electromagnetic wave propagation, and other similar applications [1].

Main advantages of this antenna system consist of the fact that it enables us on the basis of results of the required radiation identification without orientation on the source of radiation under investigation to measure the meridian θ and azimuth φ angles of the electromagnetic wave arrival, vertical E_θ and horizontal E_φ components of the electric field intensity vector, and also phase shift ψ between these components. In addition, the radio-wave frequency is also measured, since the tuning of processing channels for the frequency of radiation under investigation is performed in the signal processing device. Neglecting the modulation parameters, we obtain all the necessary quantities that characterize any specific radiation at the antenna system output [2].

However [1] does not contain metrological characteristics that essentially limit the field of application of the antenna system. For eliminating this drawback the current paper presents the results of investigating the accuracy characteristics that illustrate capabilities of the developed antenna system as a device for measuring the electromagnetic field parameters.

PROBLEM STATEMENT

A generalized diagram of antenna system presented in Fig. 1 consists of five dipoles that are integrated with signal processing units and processor unit. Dipoles *1* and *2* are located in horizontal plane and are mutually perpendicular. Dipole *3* is located in vertical plane. Phase centers of dipoles *1*, *2*, and *3* are aligned and coincide with the origin of the selected coordinate system. Dipole *4* is coaxial with dipole *3* and removed from it by distance *d*. Dipole *5* is coaxial with dipole *2* and removed from it by the same distance *d*.

Voltages from the outputs of each dipole are fed into appropriate amplification and frequency conversion channels. The transfer coefficients of channels are designated as K_s, $s = 1,5$; they characterize the properties of channel unit (CU). The amplified voltages are transformed at high frequency in the signal processing unit (SPU) into quantities required for the calculation of field parameters. The amplitude detector unit (ADU) is used to determine the amplitude voltage values representing initial data for calculation of quantities θ, φ, E_θ, E_φ, and ψ in the processor. This device is equipped with the unit of control and transfer coefficient correction (CCCU) that ensures the minimization of errors in estimating the transfer coefficients of sections from the output of dipoles to the inputs into processor.

Based on the generalized diagram of antenna system (Fig. 1) and functional links [1] between input quantities (emf at the terminals of dipoles) and output quantities (θ, φ, E_θ, E_φ, and ψ), it is necessary to show possible errors of measurements and the main sources of errors.