ISSN 0735-2727, Radioelectronics and Communications Systems, 2015, Vol. 58, No. 4, pp. 145–150. © Allerton Press, Inc., 2015.
Original Russian Text © F.F. Dubrovka, A.V. Tolkachev, 2015, published in Izv. Vyssh. Uchebn. Zaved., Radioelektron., 2015, Vol. 58, No. 4, pp. 3–11.

End-Fire Ultrawideband Low Profile Dipole-Slot Antenna

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Received in final form February 13, 2015

Abstract—This paper presents a simple end-fire ultrawideband dipole-slot antenna, which consists of a single plate dipole located above the screen and loaded by two slots, that are formed by three metal sheets. The results of numerical investigation of its matching and radiation characteristics using integral equations technique for the current and the charge are demonstrated in the article. An optimized variant of the antenna has a low profile ($0.17\lambda_{max}$) and in the frequency range with bandwidth ratio 3.2:1 it provides VSWR < 2 in the case of excitation by the 50 Ω feeder, and also it provides almost unalterable shape of the radiation pattern for the wavelengths, which are close to the λ/2 distance to the screen, what cannot be obtained for the dipole antenna above the screen. It has been shown that such an effect is achieved due to the in-phase combining of the radiations emitted by the dipole-slot system and by the screen in the front half-space.

DOI: 10.3103/S0735272715040019

INTRODUCTION

At the present time, due to the intensive development of systems for electromagnetic sounding and for the monitoring of electromagnetic environment there is a practical interest in the designing of ultrawideband (providing bandwidth ratio 2:1 and more) end-fire antennas with linear polarization, which have an extremely low profile, that is especially important for airborne applications. A planar log-periodic antenna [1], which is located above the conducting screen, potentially possess the required properties, but it has one disadvantage, namely it is the bifurcation of its radiation pattern (RP) in the case when the electrical distance between the screen and the structure is close to λ/2, where λ denotes the wavelength of antenna's radiation. A similar effect occurs for the wideband dipole antennas.

There have appeared a number of publications [2–7] related to a novel ultrawideband low profile (about λ/8 at the lower edge of the operation frequency band) planar antenna array with linear polarization of the radiation field. It consists of a system of long parallel slots, that are excited by continuous strip dipoles [2]. Theoretical investigations of such a structure have demonstrated that it has unlimited bandwidth, if the radiating slots are infinitely long and the structure is located in the free space [4].

However, the presence of the screen, which is required for a practical design, reduces the operation frequency range down to 4:1 [5], that has been confirmed by the experimental investigations [2, 3]. In addition, for presented structure the matching problem of the radiator's impedance (377 Ω) with a standard 50 Ω coaxial cable is a complex one, which leads to losses in the feeding system from 3 to 4.9 dB in the operation frequency band [6].

Further development of this antenna array wends the way to eliminate the influence of the screen on the bandwidth characteristics due to the location of electromagnetic waves absorber, which is made from the ferromagnetic material, between the screen and the radiating aperture [7]. This provides the possibility to broaden the operation frequency band up to 10:1, which is essential for electromagnetic sounding, but it leads to loss of about a half of the power. For the described prototype this has increased the weight of the antenna by 46.6 kg due to the absorber [7], which drastically limits the airborne application range.

Therefore, it is of practical interest to design a simple broadband antenna, which possess the advantages of the described antenna array and which is devoid of its drawbacks. In order to solve this problem we suggest the dipole-slot antenna in the form of a single broadband plate dipole, which is loaded by double slot formed by three metal sheets and which is located above the conducting screen of finite dimensions.