ISSN 0735-2727, Radioelectronics and Communications Systems, 2015, Vol. 58, No. 4, pp. 157–165. © Allerton Press, Inc., 2015.
Original Russian Text © O.E. Vydalko, F.F. Dubrovka, 2015, published in Izv. Vyssh. Uchebn. Zaved., Radioelektron., 2015, Vol. 58, No. 4, pp. 20–31.

Matching and Radiation Characteristics of a Phased Array Based on Quasi-Yagi Planar Antennas with an Additional Screen

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Received in final form March 3, 2015

Abstract—This article presents the results of numerical investigation and optimization of matching and radiation characteristics for a single planar quasi-Yagi antenna and for a planar phased antenna array (PAA) with size 11×11 elements, which is designed based on these radiators. The research has been performed utilizing the finite difference time domain technique. The calculations have taken into account the presence of an additional metal screen behind the radiating curtain and the feeding of each array's element via the coaxial-to-microstrip transition, that has made the model of an array as close as possible to the real PAA design and to its performance under real conditions. The levels of electromagnetic coupling between adjacent array elements have been investigated, the variations of operating characteristics of elements in its structure have been demonstrated in the case of in-phase excitation and in the scanning mode. It has been found that the possible scanning sector of this screened PAA falls within the range ±45° for the reflection coefficient of any array's element, which is less than –10 dB in the frequency range not less than 10%, and for the central element of an array the corresponding operation frequency range exceeds 30% for the scanning in *E*-plane and it is larger than 17% for the scanning in *H*-plane.

DOI: 10.3103/S0735272715040032

INTRODUCTION

Phased antenna arrays (PAA) based on microstrip antennas are of particular interest for the utilization in modern radar systems. Their main advantages over other types of PAA are small size, light weight, ease of integration with IC chips and relatively low production cost. Among antennas of such type the microstrip traveling-wave antennas are promising for radar requirements. In contrast to the resonance antennas the mentioned ones provide wide operation frequency range.

One may refer planar quasi-Yagi antenna, which provides broad operation frequency range and relatively small mutual coupling being a part of PAA [1–3], to microstrip traveling-wave antennas. Because of these properties the quasi-Yagi antennas attracted the attention of PAA developers [2–5].

This article presents the results of numerical investigation and optimization of matching and radiation characteristics for a single planar quasi-Yagi antenna if the screen is present and for the PAA based on such radiators with the account of mutual coupling between the elements. The possibilities of wide-angle scanning have been investigated for these PAA. The investigated PAA model is maximally close to the actual PAA design due to the presence of additional reflective screen designed to reduce backward radiation and to improve the mechanical design parameters, and due to the account of each element's feeding via coaxial-to-microstrip transition, which is specially developed for these purposes [6].

INFLUENCE OF A SCREEN ON THE CHARACTERISTICS OF A PLANAR QUASI-YAGI RADIATOR

Figure 1 presents the structure of an investigated planar quasi-Yagi radiator. It consists of a metal envelope of coaxial-to-microstrip transition *1*, of the input microstrip line *2* and of a microstrip Wilkinson type power divider *3*, in one arm of which the delay line is formed providing a fixed phase shift 180°. This divider represents a transition from the nonsymmetrical microstrip line to a symmetrical two-wire line, which feeds a symmetrical dipole antenna. A director *4* is located above the dipole. The antenna has a