ISSN 0735-2727, Radioelectronics and Communications Systems, 2009, Vol. 52, No. 10, pp. 537–544. © Allerton Press, Inc., 2009.
Original Russian Text © T.A. Suanov, B.M. Petrov, 2009, published in Izv. Vyssh. Uchebn. Zaved., Radioelektron., 2009, Vol. 52, No. 10, pp. 35–46.

Scattering Characteristics of Non-Linear Loaded Two-Sided Corner Reflector

T. A. Suanov and B. M. Petrov

Taganrog Institute of Technology, Southern Federal University, Taganrog, Russia

Received in final form December 22, 2008

Abstract—Method of integral equations of sideband component of surface currents and physical optics method can be used for calculation of non-linear corner reflector. Efficient equivalent areas of backward scattering at frequencies of incident field and sideband frequencies are calculated.

DOI: 10.3103/S0735272709100045

Most positioning problems, which are in essence unsolvable with application of classic radiolocation methods, can be solved if target radiolocation contrast is specified by probing signal spectrum transformation possibility. First of all, these tasks include detection of radio beetles for illegal access to audio- and video-information, hidden weapon, defects, etc, i.e. in general case, the task is to detect objects, containing semiconductor elements, or metal-semiconductor contacts, or nonlinear contacts of metal–dielectric–metal type [1–3], which are remote from the locator to small distance. Also important problem of non-linear radiolocation is a problem of detection of people in distress. People, who take part in potentially unsafe activity, for example, mountain ascent, forest trip or sea voyage, must be provided with special nonlinear markers [4, 5]. In case of avalanching, reference points loss, or shipwreck, the earliest people detection using their markers allows to save their lives. Markers, which are nonlinear reflectors, allow to detect peoples under cover of snow, leaves or on a sea surface background, using signals, reflected at frequencies of nonlinear products (mixed harmonics of probing signal). In addition, nonlinear reflection properties can be used for development of reflectors with controlled reflection characteristics, adaptive antenna systems, antenna systems with integrated signal processing. List of application fields is not exhaustive, of course.

Nonlinear markers application is efficient in case of two conditions are satisfied. First, maximal distance of marker detection by nonlinear locator is about few hundreds or thousands meters, second, reverse scattering pattern (RSP) is uniform in enough wide sector of observation angles. Application of several reflectors in form of nonlinearly loaded oscillators [4, 5] or reflectors with wide RSP allows to satisfy the second condition. The first condition satisfying is more complicated problem. Direct methods application, such as increase of receiver sensitivity or power of probing signal, does not result in distance gain, practically, or they are not advisable always, therefore, a problem of development of nonlinear reflector, which efficiently converts incident field energy into scattered field with nonlinear products frequency, is actual now. This way is advantageous and promising, but labor-consuming, since it is necessary to develop the models of scattering of electromagnetic (EM) field on objects with nonlinear properties. Since marker size also is restricted by specific requirements, used frequency band is also restricted (in case of nonlinearly loaded oscillators this restriction is not so essential). Application of centimeter SHF wavelength range allows to decrease reflector dimensions, but at the same time specific electrical dimensions of areas, fulfilled by nonlinear material, increase; it means that a problem of these reflectors analysis becomes purely electrodynamical (there is no method to reduce a model to electric circuit and solve the problem with one of known circuits theory method). Further we represent one of electrodynamic method application to a problem of EM field scattering on two-side angled reflector with nonlinear load and some numerical results.

Nonlinear angled reflector is a metallic corner with parallel to edge thin plane nonlinear dielectric strips on the sides.

To develop a model of EM waves scattering by such reflector we used approximate boundary conditions on infinite metallic wedge strips, which required studying of electrodynamic properties of metallic plane, covered with nonlinear matter layer [6]. Nonlinear boundary conditions at a strip were applied for approximate formulation of boundary problem of excitation of a wedge with nonlinear strips on its sides.