LOW PROFILE, 2D-SCANNING MMW ANTENNA CONTROLLED BY TWO CURRENTS

Zaitsev E.F., Gouskov A.B., Cherepanov A.S.
St.Petersburg State Techn. Univ., Russia
Yufit G.A., Beltran M.R., Khodorovsky Y.S.
Beltran Inc., NY. USA.

ABSTRACT

The design of planar phased array made on the basis of controlled waveguiding FDF-structure (ferrite-dielectric-ferrite) has been represented. Main difference of this antenna type from those ones described earlier is that 2D-beam scanning is provided by means of two control currents only. Experimental sample of 8-mm antenna has been fabricated and its parameters have been measured.

INTRODUCTION

Problem of creation of scanning MMW antenna is not yet solved completely. One of real ways of the problem solving is the using of integrated phased arrays (IPA) with ferrite control [1-2]. Such antennas can be realized in a whole MMW band, they have low profile design. Low-cost in comparison with conventional microwave phased array is also a very important advantage. It clears the way to a wide application of these antennas.

THE ANTENNA DESIGN

The antenna presented in this paper has an extremely simple beam control. Radiating structure of the antenna contains two ferrite layers, between which thin rods of dielectric ceramics are disposed parallel to each other. In the clearances between dielectric rods control wires are disposed, they are reeled on the bottom ferrite layer. The last one has metallized bottom surface, which operates like a screen. Radiating dipoles are sprayed on the outer surface of the top layer. Thus the radiating structure forms an array of linear waveguide-dipole antennas [1]. Magnetizing of ferrite layers due to current in control winding causes phase velocity variation in all FDF-waveguides. This provides the antenna scanning in *H*-plane.

Distributing unit with phase control is a new element in this antenna. It contains a controlled FDF-waveguide identical to those, which form radiating structure. Dipoles disposed on its surface radiate not in the outer space, but in the system of empty waveguides, which provide connection of the distributor with inputs of radiating structure. The distributor has its own control winding, which provide scanning in *E*-plane. Hence, the antenna realizes 2D-scanning by 2 control currents.

Electric field at distributor output is polarized vertically, whereas there is a horizontal field polarization in radiating aperture. So each empty waveguide has 90^{o}-twist, which is formed by a septum with inclined resonant slot.

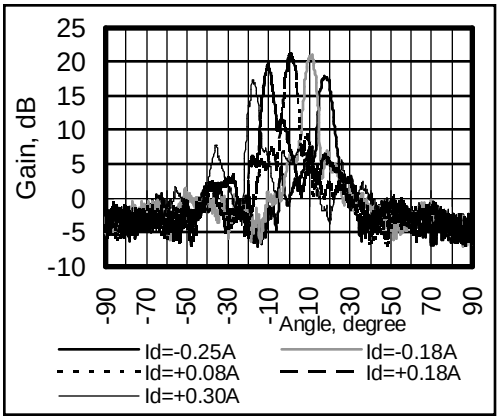

Figure 1. *E*-plane Pattern Diagram

0-7803-4471-5/98/$10.00 (c) 1998 IEEE

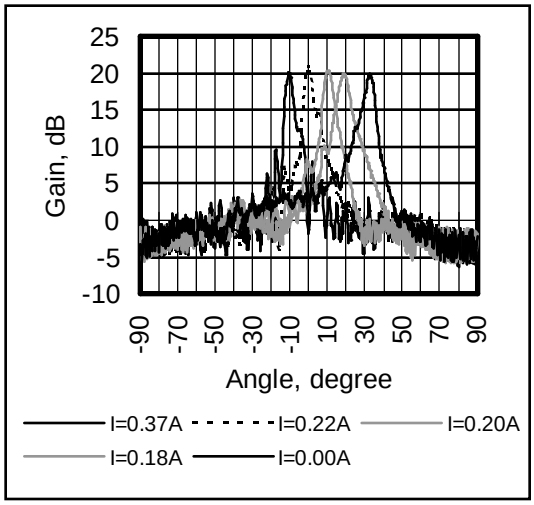

Figure 2. *H*-plane Pattern Diagram

There are also phase shifters with mechanical adjusting in each waveguide for initial phase error correction. Empty waveguide is connected with FDF-waveguide by means of dielectric matching transformer – the same transformer is mounted at common input of the distributor.

EXPERIMENTAL STUDY

Fig.1 shows pattern diagrams of the antenna, which where experimentally measured in *E*-plane for different values of current I_d in the power distributor. Control current I_a of the antenna itself is constant; its value corresponds center of scanning sector in *H*-plane. In Fig.2 the experimental pattern diagrams in *H*-plane for various antenna control currents I_a ,when I_d=const, have been presented.

General parameters of the antenna are given in Table 1.

The measured antenna parameters (beamwidth, gain, side lobes level (SLL), sector of scanning) are close to calculated ones. SLL -11 dB is caused by the fact, that field amplitude in the aperture decreases approximately

Table 1

Dimensions of the radiating aperture	120×108 mm
Number of radiating dipoles	28×20
Beamwidth	5 deg.
Scanning sector in *E*-plane	-17...+17 deg.
Scanning sector in *H*-plane	-33...+12 deg.
Gain	18-21 dB
Side lobe level	-11 dB
Control current range for scanning in *E*-plane for scanning in *E*-plane	 ±500 mA ±500 mA
Control winding resistance	7 Ohm

exponentially from the antenna input to other antenna edges. The linked with it area efficiency value is - 2dB. Absorption loss in the radiating structure is 3 dB; the same value of loss is in the phase-controlled power distributor. Using of more qualitative dielectric ($\tan\delta \le 2\cdot10^{-3}$) allows to diminish absorbtion losses by 2 dB at least.There aro also additional losses about 3 dB, which can be lowered afterwards. Thus it is possible to raise the antenna gain upto 21-24 dB. Simultaneously beam width can be narrowed to 3^o.

Applications of the antenna is most expedient in the devices, where the main requirements are low cost (in this case about $2000) and simple beam control.

REFERENCES.

1. Zaitsev E.F., et. al. «MM-wave Integrated Phased Arrays with Ferrite Control». *IEEE Transactions on Antennas and Propagation*. Vol. 42, N 3, March, 1994, p.1362-1368.
2. Zaitsev E.F., et. al., «Innovative integrated ferrite phased array technologies for EHF radar and communication applications, *IEEE International Symposium on Phased Array Systems and Technology,* Oct. 15-18, 1996, Boston, US, p..74-77.