1-II C4

INVESTIGATIONS ON STRIPLINE END-FIRE ANTENNAS PRINTED ON CERAMIC SUBSTRATES FOR THE RANGE OF 10 GHZ

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The purpose of these investigations was to design an antenna with very small physical size, good directivity and a practicable connection to integrated microwave circuits. For this reason the same technology for the antenna as for the integrated circuits is used. First investigations have been made with copper cladded polyguide. A symmetric folded dipole with input impedance of 200 Ω was used. The transformation from the symmetric 200 Ω -input to the asymmetric 50 Ω -feeding line was performed by a half-wavelength deviation-line with 100 characteristic impedance. On the dielectric plate with a size of 16 mm x 120 mm the dipole, two reflecting strips and 12 directors are arranged, all manufactured by fotoetching of the copper layer of the polyguide material. The length of the folded dipole, the length of the deviation-line, the length and the distance of reflectors and directors have been changed step by step and designed, that the input reflection coefficient at the frequency of 9,4 GHz got a minimum.

During these reflection-measurements it is important to move a metal plate in front of the radiating element of the antenna. In this case some points of total reflection must be measured, otherwise losses in the transformation circuitry act as matched termination and the antenna will have a bad efficiency.

For this antenna, used for a walkie-talkie with a Gunn-oscillator, a reflection coefficient of 3 %, a width of the horizontal diagram of $\pm 18^{o}$ and of the vertical diagram of $\pm 20^{o}$ was available. The side-lobe suppression was 7 dB and the gain 15 dB.

A reasonable reduction in size of this type of antenna is possible by application of ceramic-substrates with a dielectric constant of about 10. We use Al_2O_3-substrates with a purity of 99,7 % and an adhesive sheet of tantalum and a conduction sheet of silver; both are evaporated by cathode sputtering in argon atmosphere. The building up of the silver and the protection by gold is made after fotoprocessing by electro -plating. The last working cycle is the etching in order to produce the circuit structure.

The complete antenna with deviation line and 8 directors is printed on a substrate of 25 mm x 50 mm size. The feeding and deviation line is an asymmetric microstrip and the silver-ground-plate on the opposite side is ended on the location, where the reflector-strips are situated on the side of striplines. Besides the length of the dipole the distance to the end of the ground plane and the distance to the front-end of the dielectric substrate has a strong influence to the value of reflection coefficient and to the resonance frequency - i.e. the frequency with minimum reflection coefficient. A number of antennas with successive modifications of the different dimensions resulted in a model, which could be manufactured with reproducible properties.

The length of the dipole has an optimum at 7,45 mm and the distance between the radiator and the end of the ground-plane on the opposite side is 2 mm.

The input-reflection coefficient is less than 3 % (30 dB) at 9,35

GHz and less than 10 % (20 dB) between 9,3 and 9,4 GHz. The radiation power falls down 1 dB between 8,9 and 9,7 GHz and 3 dB between 8,5 and 9,9 GHz. The 3 dB-angle of the radiation pattern is $\pm$ 22° in horizontal direction and $\pm$ 20° in vertical direction, the sidelobe suppression is 9 dB respective 15 dB and the back and forth ratio is 20 dB. The gain is 14 dB.

The antenna-dipole on the same substrate without directors shows a radiation pattern with $\pm$ 35° in horizontal and $\pm$ 30° in vertical direction.

Fig. 1 shows the lay-out of the antenna structure in natural size. Fig. 2 describes the reflection-coefficient vs. frequency and Fig. 3 shows the vertical radiation pattern - it means the diagram plane is the same as the antenna-substrate - in logarithmic scale. The radiation pattern of the antenna have been plotted with an automatic polar-coordinate-recorder, where a Gunn-oscillator has been used as transmitter directly mounted on the antenna-substrate avoiding the use of a rotational joint.

Investigating the guidance properties of the ceramic-substrate we measured the wavelength near the surface by displacement of a perpendicular metal sheet on both sides of the substrate. Measured was the distance between two maxima of the reflection coefficient. As result the value of the effective dielectric constant ε_{reff} depending of the distance z to the radiating dipole is plotted in Fig. 4. The upper curve (1) describes an antenna with directors, the lower curve (2) shows an antenna without directors. The higher value of indicates the guidance of the directors to.

The influence of the front-end of the ceramic-substrate on the impedance was investigated by shortening a very long substrate piece by piece. A half-wavelength-dependence was ocurring with stronger influence on shorter substrates.

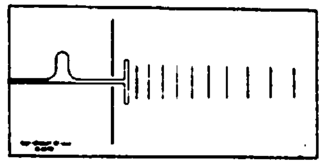

Fig.1

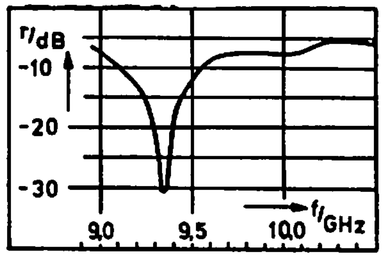

Fig.2

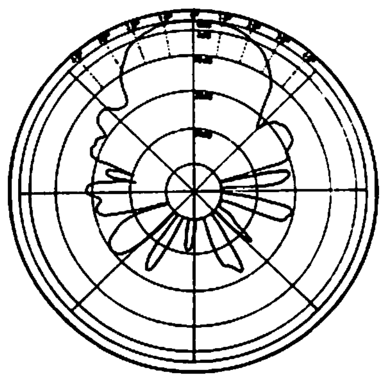

Fig.3

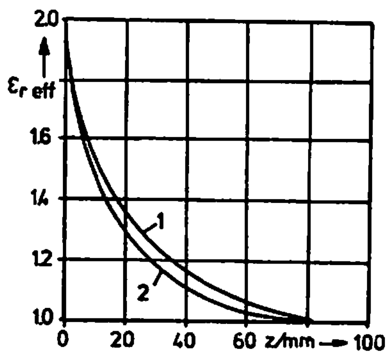

Fig.4