FIELDS AT THE APERTURES OF HORNS LOADED WITH ABSORBING SLABS

S I Ghobrial R E Kamil H R Sharobim
Elec Eng Dept. University of Khartoum, Sudan

Introduction: This paper deals with the field distribution at the apertures of pyramidal horns loaded with absorbing slabs. Measurements carried in the past on the field distribution at the apertures of unloaded pyramidal horns showed that modes other than the TE_{10} exist, which is expected. The TE_{12} mode in particular has an amplitude that is higher than those of all other modes apart of the TE_{10},(1). At 9.5GHz the amplitude of the TE_{12} was found to be about -20dB relative to the TE_{10} mode amplitude.

It can be readily shown that the presence of the TE_{12} mode at the aperture causes radiation of cross-polarized fields. Thus reduction of far field cross polarization may be achieved by suppressing this mode. A different method for reducing cross polarization in pyramidal horns was suggested by Ghobrial and Sharobim (2). In this method the walls of the horn perpendicular to the Electric field are covered with a layer of some absorbing material. This causes a reduction in the walls' currents and therefore in the radiated fields from these walls. These fields are cross polarized relative to the main TE_{10} field. Using this method Ghobrial and Sharobim were able to reduce cross polarization by 7dB.

The question as to whether reduction of wall currents also causes a reduction in the level of the TE_{12} mode thus arises. The significance of this is evident; for if reduction of wall currents causes a corresponding reduction in the TE_{12} amplitude then it is sufficient for the reduction of far field cross polarization. On the other hand if the level of the TE_{12} is not affected then cross polarization results from both currents on the walls of the horn and the presence of the TE_{12} at the aperture.

Measurements and Results: To investigate the effect of the absorbing material on the level of the TE_{12} at the aperture of the horn measurements of the field distribution at the aperture of an 8 cm by 8 cm pyramidal horn were carried out. The technique used is due to Cullen and Parr (3). The two dimensional distribution thus obtained was then subjected to a Fourier analysis technique to determine the modes present at the aperture and their levels. This experiment was first carried with the walls of the horn covered with nothing. This was then repeated with the walls covered with slabs of varying lengths; all made of the same material and of the same thickness. The material used for this purpose had a dielectric constant of 11.0-j5.5 and a thickness of 2 mm. The outcome of these investigations is shown in Table I. Since the mode of interest here is the TE_{12} Table I gives the relative level of this mode only. The numbers in the second and fourth columns are in dB relative to the TE_{10} level.

Table I: Level of TE_{12} for different slab lengths

slab length (cm)	level of TE_{12} (dB)	slab length (cm)	level of TE_{12} (dB)
0.0	-17.9	4.0	-18.4
1.5	-22.1	4.5	-18.3
2.0	-21.3	5.0	-18.6
2.5	-18.2	5.5	-20.5
3.0	-18.9	6.0	-20.5
3.5	-18.3	6.5	-21.4

From the above table it is seen that covering the walls of the horn with an absorbing material results in some reduction in level of the TE_{12} mode. A maximum reduction of 4.2dB is achieved with slabs of 1.5cm length. Increasing the slab length does not cause a further decrease in the level of the TE_{12}. On the contrary the level increases reaching, almost, the unloaded level for a slab of 2.5cm length.

These results seem to suggest that cross polarization in the far field is caused by radiations from wall currents and from an aperture disribution in the TE_{12} mode.

The relative contributions of these effects to far field cross polarization are still under investigation. There is some evidence, however, that the main cross polarization lobes are generated by wall currents while the second lobes are radiated by aperture field distribution in the TE_{12} mode. This is shown by the reduction of the main lobes as a result of covering the walls of the horn with an absorbing material by more than 10dB. The second lobes are reduced by less than 0.5dB under these conditions. All attempts to reduce the second lobes by reduction of wall currents have, as yet, failed.

Conclusions: Far field cross polarization in pyramidal horns result from two effects: (i) wall currents, and (ii) TE_{12} field distribution at the aperture. Wall currents are responsible for the main cross polar lobes while aperture fields can be the cause of the second lobes.

References

(1) S I Ghobrial: "Fields at the aperture of pyramidal horns" 1981 IEEE AP-S International Symposium; pp 448-451 in symposium digest.

(2) S I Ghobrial and H R Sharobim: "Cross polarization reduction in pyramidal horns"; 1988 International Wroclaw Symposium on Electromagnetic Compatibility, Wroclaw, Poland; pp277-281.

(3) A L Cullen and J C Parr, Proc IEE, 102B, Nov 1955, pp836-844.