THE ORTHO-MODE VIVALDI ANTENNA

ANTONIO DIAS DE MACEDO FILHO
IPqM - BRAZILIAN NAVY RESEARCH INSTITUTE

MARBEY MANHÃES MOSSO
CETUC/PUC CATHOLIC UNIVERSITY

INTRODUCTION

The vivaldi antenna has been the topic of several recent investigations (1,2). It is small light-weight and easy to be manufactured. However this kind of aerial is limited to linear polarization. This constraint restricts it´s application in some specific systems such as polarization finders or polarization diversity transmitters.
For EW purposes, for example, it´s important to determine the polarization of an incoming wave since the effectiveness of a jammer with improper polarization is reduced. If the objective is to jam a monopulse seeker, then it may be best to return it´s orthogonal polarization to fill in monopulse error channel nulls and deprive the seeker of angle information, or at least greatly reduce the tracking accuracy.
Polarization measurements are also very important for ELINT and ESM because they can aid the understanding of the radar function, and in the analysis of the received data.
The Ortho-Mode Vivaldi (OMV) antenna system presented in this paper is able to cope with all kinds of polarization since it is composed by a set of two orthogonal linearly polarized elements that are suitably feeded by an Ortho-Mode Tee (OMT).

DESIGN CONSIDERATIONS FOR THE ORTHO-MODE VIVALDI

Ortho-Mode Tees have the unique property of being able to separate orthogonal polarizations at any frequency within their operating bandwidth, even at the same frequency (3). In the schema of fig. 1, the top ridge of port 1 is connected to quadridges 1 and 2 of port 3 while the botton ridge is to quadridges 3 and 4. In a similar manner the two ridges of port 2 are electrically connected to quadridges 2 and 3 and 1 and 4. This provides two spatially orthogonal E vectors of equal

amplitude. If a 90 degree phase shift between them is assured then the generation of circular polarization is obtained.
The OMT feeder offers the advantage over printed line (4), or coaxial cable (5), feeding structures for orthogonal slotline aerials that each single feed doesen't need to cross the other element apperture, disturbing the electromagnetic fields at the cross-over point and reducing considerably the gain of both elements. A second advantage is that for traditional feeders it would be imperative to impose an off-set on one of the elements, this causes a distortion in the axial ratio of the system. The reason for such effect is the spatial phase delay $\Delta\Psi = \beta$ d sen 0, between the two elements. As the major displacement will be in the y-direction this means that the largests errors will occur near the boresight what is particularly undesirable in most applications as studied by Hung (6).
Observing the field arrangement at port 3 of the OMT of fig. 1, it can be seen that the opposite quadridges are very similar to the edges of a slotline transmission line (7). Then, the transition from the OMT to the Ortho-Mode Vivaldi system can be made by separating quadridges 1 and 2 respectivelly from 3 and 4 in an exponential manner. The Vivaldi elements must he made of a thin metal sheet in order to minimize the effect over high frequencies imposed by t, the conductor layer thickness. The air substrate enhances the increased gain characteristic imposed by dielectric loading as proposed by Macedo F. (8) et al.

PRATICAL RESULTS

The OMT used to feed the designed OMV was a commertial OMT. It's quadridged flange is designed for the 6 to 18 Ghz band.
The first prototype was assembled as a fixed structure by four half-Vivaldi elements. The material applied was aluminum. This metal is easily machined providing practically no RF discontinuities due to contact between parts. Although special equipment is required to weld aluminum, the resulting structure is lighter in weight than brass or copper. This feature enable the use of industrial glue to etch the elements to a fixed flange ensuring the contact only in the quadridges.
The results of the OMV system shown in fig. 3 are presented in fig. 4.
One should note that:
a) The antenna w/mica dielectric overlay has a better response

up to 8.5 Ghz, for higher frequencies the response is limited by the severe losses of the mica.

b) For a spec. of 12 dB gain aprox. 4 to 18 Ghz band is achieved without mica.

c) This prototype is mechanical very delicate.

d) The output from port 1 is aprox. 6 dB stronger then port 2 because of poor VSWR presented by the OMT.

e) Silver depositation will increase these performances.

The dielectric overlay applied was mica. The reason for this choice was both economical and to garantee the light-weight of the OMV.

CONCLUSION

It was shown how an orthogonal set of Vivaldi elements can operate using an Ortho-Mode Tee feeder. The results presented shown that large bandwith and a 12dB gain can be achieved.

REFERENCES

1. Y. A. Aziz et al, "Design of Vivaldi Antenna for Microwave Integrated Circuits Applications", 14th European Microwave Conf., Brussels 84.

2. M. Helier, P. Eartigue & Delecointe, "Etude d´antennes planes a ligue de frente non Uniforme", JINA´86 Nice, nov. 4-6/86 pag. 224-228.

3. H. Schlegel & W. D. Fowler, "The Ortho-Mode Transducer Offers a Key to Polarization Diversity in EW Systems", MSN, september 1984, pag. 65-70.

4. A. Podcameni & M. L. Coimbra, "Slotline Transition on Iso / Anissotropic Substrate Broad band Design", in: 1971 Int. Microwave Symposium Digest IEEE MTT-S, pp 80-82, Los Angeles.

5. K. B. Knorr, "Slotline Transitions", IEEE Trans on Microwave th, and Techn., vol MTT-22, May 74, pag. 548-554.

6. J. Huang, "A Techniques for an Arrau to Generate Circular Polarization with Linearly Polarized Elements", IEEE Trans on Ant. and Propag., vol AP. 34, No 9, Sept. 86, pag 1103-1124.

7. K. C. Gupta, R, Gar and I. J. Bahl "Microstip Lines and Slotline", Artech House, Dedham Ma USA, pp 235-244.

8. A. D. Macedo F., A. Podcameni & M. M. Mosso "A Dielectric Overlay Compensated Slotline Printed Antenna", JINA´86, Nice, Nov 4-6/86, pag. 180-183.

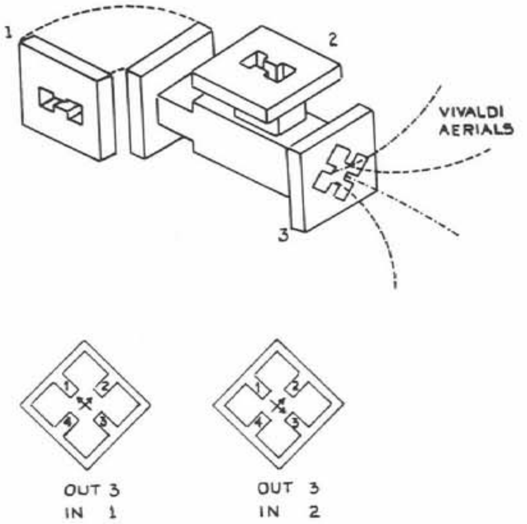

Fig. 1 - OMV Antenna System

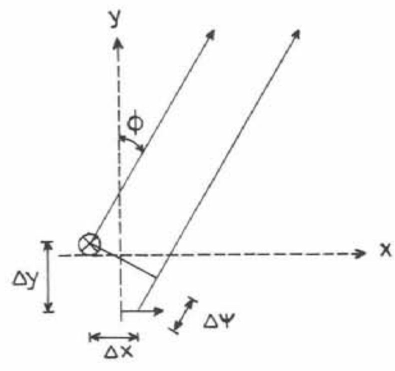

Fig. 2 - Spatial phase delay ΔΨ due to off-set of the orthogonal elements.

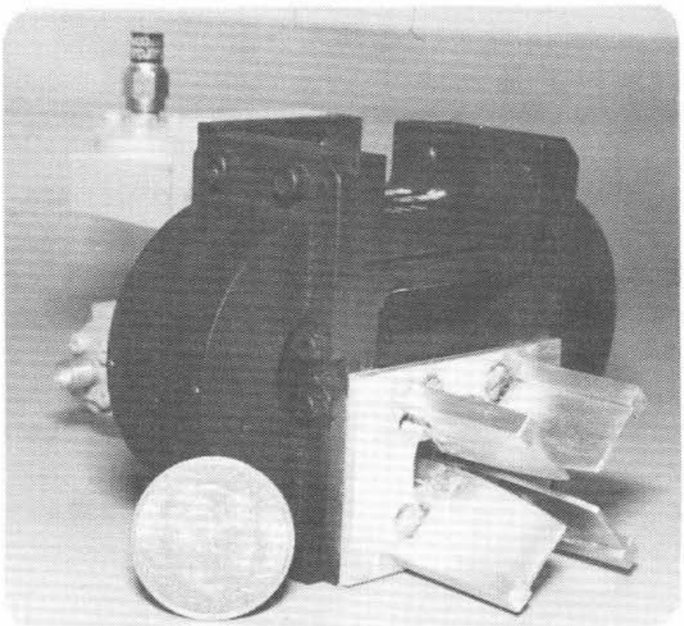

Fig. 3 - The OMV Prototype (coin 1 Krone Danmark)

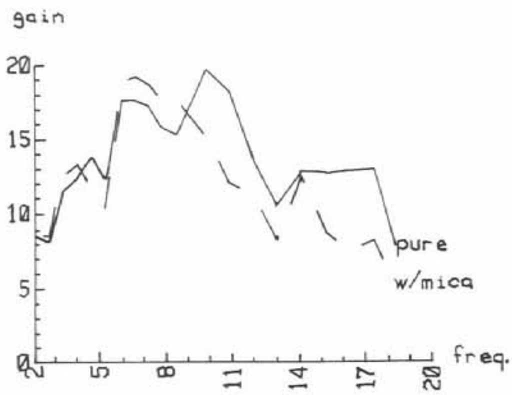

Fig. 4 - Results of OMV Prototype.