Digital Antenna Unit for DOA Analysis in ESM Systems

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***Abstract*— In this paper, design and characterization of a novel "Direction Finding Antenna" unit (D/F DAU) are presented. The unit has been designed in order to localize electromagnetic emitters with precision direction finding capabilities. The Antenna is employed in the ELT avionics and naval modern ESM sensing system and utilizes an amplitude direction finding scheme. The main characteristic the D/F DAU is the ability to cover the signal pulses visibility in presence of simultaneous CWs emitters. An evidence of the used techniques, electromagnetic simulations, three dimensional outlines, measurements and obtained performances are explained. A paragraph of the article is focused to describe the characteristic of the Antenna to cover the signal pulses visibility in presence of simultaneous CWs emitters.**

I. INTRODUCTION

Wide open ESM systems are generally known as high probability of intercept systems [4].

In a ESM receiver one of the main function is to provide the information about the direction of arrival for each received signal CW or modulated with a frequency included in a multi-octave bandwidth.

The signals comparison is the DF technique utilized today in the Electronic Support Measure (ESM) Systems [1]. In amplitude DF techniques, the measurement accuracy is based on the comparison between signals received by directional radiating elements [2], [3], installed in the system to have diverging beams in the spatial coverage requirements.

The main functions of (D/F DAU) are:

- Receive and filter out electromagnetic signals from the environment;
- Detect and amplify the signals by detectors and logarithmic amplifiers; - Sample and digitally convert the analogue signal detected;
- Transfer sampled signals to the system processor, using optical fiber to calculate the Direction of Arrival (DOA), Amplitude and Pulse Width (PW) of the input signal;
- Filter, amplify the coupled Radio Frequency signal to the digital interferometer receiver (DIFM) for the frequency measurement;

The outline of the Antenna is shown in the next Fig. 1.

The unit is composed by a 0.5-18GHz Log Periodic Dipole radiating element arranged to form squared-bottom pyramid shape. The radiant element is connected to the microwave front end module containing a video log channel and a digital board that receive the analogues signals from the detectors, convert it in digital data, and partially processing them. Finally the data are converted in optical and sent by fiber channel to the main receiver.

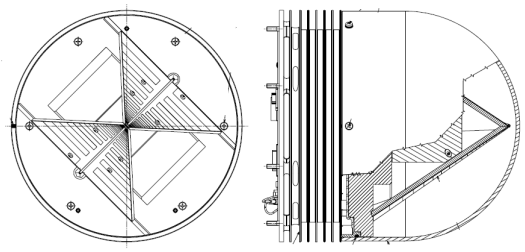

Fig.1: Parametric Geometry for Vivaldi Element

II. CONCEPTS GONIOMETRIC ALGORITHM

The two primary techniques used for direction finding are the amplitude-comparison method and the interferometer or phase-comparison method. The phase-comparison method generally has the advantage of greater accuracy, but the amplitude-comparison method is used extensively due to its lower complexity and cost.

The D/F DAU unit utilizes a LPA Antenna elements whose patterns can be approximated by Gaussian-shaped beams:

Gaussian-shaped beams; (Voltage vs **Q**)

Beam width: **Q**B

Beam distance: **Q**Q

The goniometric data is compiled on the basis of a comparison of the two beams

Gaussian-shaped beams have the property that the logarithmic output ratio slope in dB is linear as a function of angle of arrival. Thus, a digital look-up table can be used to determine the angle directly.