DESIGN AND PERFORMANCE ENHANCEMENT OF VIVALDI ANTENNA

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ABSTRACT

Now a days the ultra-wide band antenna (UWB) is generally used in special applications such as microwave imaging, wireless communications, remote sensing and in biomedical field. A computer aided design of Vivaldi Antenna is developed which is used to study the effect of different parameters such as rate of opening of exponential slot and size of the radius of circular slot on the show of the Vivaldi Antenna. The study shows the key features that affect the gain , electric field , SWR and Side Lobes pattern. The design is first simulate on COMSOL Multi physics software, FR4 substrate having dielectric constant 3.38 and fabricated design . The simulation and experimental results show that the SWR is 1.15 at 1.15 GHZ frequency and radius of antenna is 10 .Electric field is in this paper 64.

Key Words: Vivaldi Antenna, COMSOL Multiphysics, Copper Plate (FR4, 3.38 dielectric value)

INTRODUCTION

The Vivaldi antenna belongs to the class of antenna structures which are defined as a periodic continuously scaled travelling wave. It is first recognized by Gibson in 1979. Vivaldi antenna shows marvelous advantages in the field of efficiency, high gain, wide bandwidth and simple geometry. The Vivaldi antenna is a special kind of tapered slot antenna (TSA), having an exponentially tapered slot profile. The Vivaldi antenna comprises of mainly the ground plate which is FR4, dielectric substrate . This antenna comprises of three different type of slotlines which are:

(i) The circular slot which is used to realize the impedance matching of the microstrip transmission line.

(ii) The rectangular slot which is used to couple the electromagnetic wave from the microstrip
transmission line.

(iii) The exponential tapered slot which is used to guide the electromagnetic wave to radiate.

LITERATURE SURVEY

For quick understanding of the following work, first step is to take a view on the work done previously.

Osama M. Dardeer, Tamer G. Abouelnaga, Ashraf S. Mohra, Hadia M. El-Hennaw (2016)[1]This paper presents a novel four elements ultra wideband (UWB) antipodal Vivaldi antenna(AVA) array design for radar and microwave imaging applications. Next, the substrate end is shaped as a triangular shape and a negative index metal material (NIM) has been incorporated into the AVA aperture to act as a director. A gain enhancement of 2 dB is obtained for the proposed element compared to conventional one. The proposed antenna element is fabricated and measured. There is a good consistency between the simulated and measured return loss. In addition, four UWB Vivaldi antennas with substrate end shaping are placed along the z-axis in a linear antenna array configuration. The four NIM structures of the four antennas are placed together to form a sheetwhich is perpendicular to the four antenna substrates. A gain enhancement of about 6 dBi isobtained compared to the proposed single element through the whole UWB frequency range. Theproposed antenna array bandwidth extends from 3 GHz to 16 GHz. The proposed antenna arrayis fabricated,measured, and good agreement is obtained between simulated and measuredreflection coeffcients.

Professor Dept. of Electronics and Telecommunication Engineering, Yeshwantrao Chavan College of Engineering (2015)

As the traffic in wireless channels is growing day by day we need smarter devices to adapt and manage working in such networks. Cognitive radio is one such elegant solution. A frequency reconfigurable antipodal Vivaldi antenna (AVA) is presented covering whole UWB

(3.1GHz-10.6GHz) at particular switch position for cognitive radio application. Reconfiguring it to achieve several narrow bands at various switch configurations. We achieved reconfiguration with the help of switches in the feed line .The proposed antenna was designed and analyzed by using software HFSS(High frequency structure Simulator)13.0. The proposed antenna uses FR-4 substrate.

G. K. Pandey, H. S. Singh, P. K. Bharti, A. Pandey, and M. K. Meshram (2015)

An Ultrawideband (UWB) high gain compact Vivaldi antenna with end fire radiation patterns is presented for radar and microwave imaging applications. The antenna is operating for 2.9GHz to more than 11GHz with -10dB impedance bandwidth and is designed on low cost FR4 substrate of thickness 0.8mm. While designing the proposed antenna, initially a compact exponential tapered slot Vivaldi antenna is presented for wide impedance bandwidth performances. Further, the Vivaldi antenna is modified by incorporating corrugations1 on the edges of exponential metallic flaring section and some periodic grating elements consists of small metallic strips on the slot area, which results in improvement in gain significantly along with increased directivity and lower frequency band coverage. The proposed antenna shows nearly stable end-fire radiation patterns throughout the frequency range. The surface current distributions and input impedance plots are presented to understand the antenna mechanism.

ANU R G, S.Santhosh Kumar(2014) Antenna designed for ultra wide band (UWB) applications should offer a wider bandwidth with minimum distortion of pulses. One such antenna which meets these requirements is the Vivaldi antenna. In a conventional Vivaldi antenna the radiating flare is restricted to take an exponential profile. This paper presents the design of slot loaded Vivaldi antenna, using Fourier series approach. Here the geometry of the profile is not restricted and takes an optimized shape, to meet the objective of maximum gain subject to minimum reflection coefficient (S11). Antenna performance obtained from simulations and hardware prototype measurements shows good agreement, which verifies the proposed design concepts.

Debdeep Sarkar, Kumar Vaibhav Srivastava (2013) This paper presents design of a novel compact UWB antipodal Vivaldi antenna, where band-notch characteristics within 5-6 GHz frequency range is achieved by placing a parasitic rectangular SRR near the radiating arm, in order to reduce electromagnetic interference with IEEE 802.11a and HIPERLAN/2 systems. Simulation results show that the proposed antenna provides wide impedance band-width with satisfactory rejection in the desired band along with good gain and stable radiation pattern in the rest of the UWB regime.

D. ZIANI KERARTI, F.Z MAROUF, S.M. MERIAH,(202) A Simulation of a small sized antipodal Vivaldi antenna for ultra-wideband (UWB) applications is presented in this paper. By using commercial electromagnetic simulation software CST Microwave, some parameters like return loss (S11), Voltage Standing Wave Ratio (VSWR), radiation pattern has been performed to test the validity of simulation and verify eligibility of the antenna for UWB systems. The antenna design with dimensions of 58×60 mm achieves satisfactory impedance matching and radiation across the frequency band from 2.14 to 11.33 GHz with more than 136% fractional bandwidth.

Li Ying, Chen Ai-xin(2008) Vivaldi antenna is a kind of slot-line UWB antennas, which is a high-gain and linearly polarized antenna. Theoretically, it has a very wide frequency band. And its gain keeps constant with frequency changed. This paper starts from a single balanced Vivaldi antenna element, designs and analyzes a balanced vivaldi array. Then this array is used as the feed of a paraboloid antenna to get more than 35dB power gain. This kind of paraboloid antennas is widely used in the realm of long distance communications and high resolving radars Introduction .

Matthias John, Max Ammann, Patrick McEvoy (2008) A printed UWB Vivaldi antenna is presented in this paper. Its geometry is based on a novel spline shape and optimised by an efficient global optimisation algorithm. A U-shaped slot is introduced into the geometry to notch out the 5.1 GHz to 5.8 GHz WLAN band. This can be used to mitigate interference between WLAN and UWB systems.

Y. Yang, Y. Wang, and A. E. Fathy (2008) Two different types of Vivaldi antenna arrays have beend esigned for UWB see through wall applications. The first is a 16 × 1 antipodal Vivaldi antenna covering 8–12 GHz, and the second is an 8×1 tapered slot antenna for 2–4 GHz frequency range. The array elements are optimized to have a compact size and almost constant gain with frequency. Wilkinson power dividers were designed and fabricated to compose the feed network for the Vivaldi antenna arrays. Measured results of the manufactured antipodal and tapered slot Vivaldi antenna arrays are in excellent agreement with the simulated ones, with a gain of more than 13dBi and 12 dBi respectively within their respective operating band. The first array is geared towards see through dry wall with high resolution, while the second is designed at lower frequencies to allow see through concrete wall applications. Full arrays were manufactured and connected to multi-throw switches and have been utilized as part of synthetic aperture radar.

METHODOLOGY

The steps to design a Vivaldi Antenna :

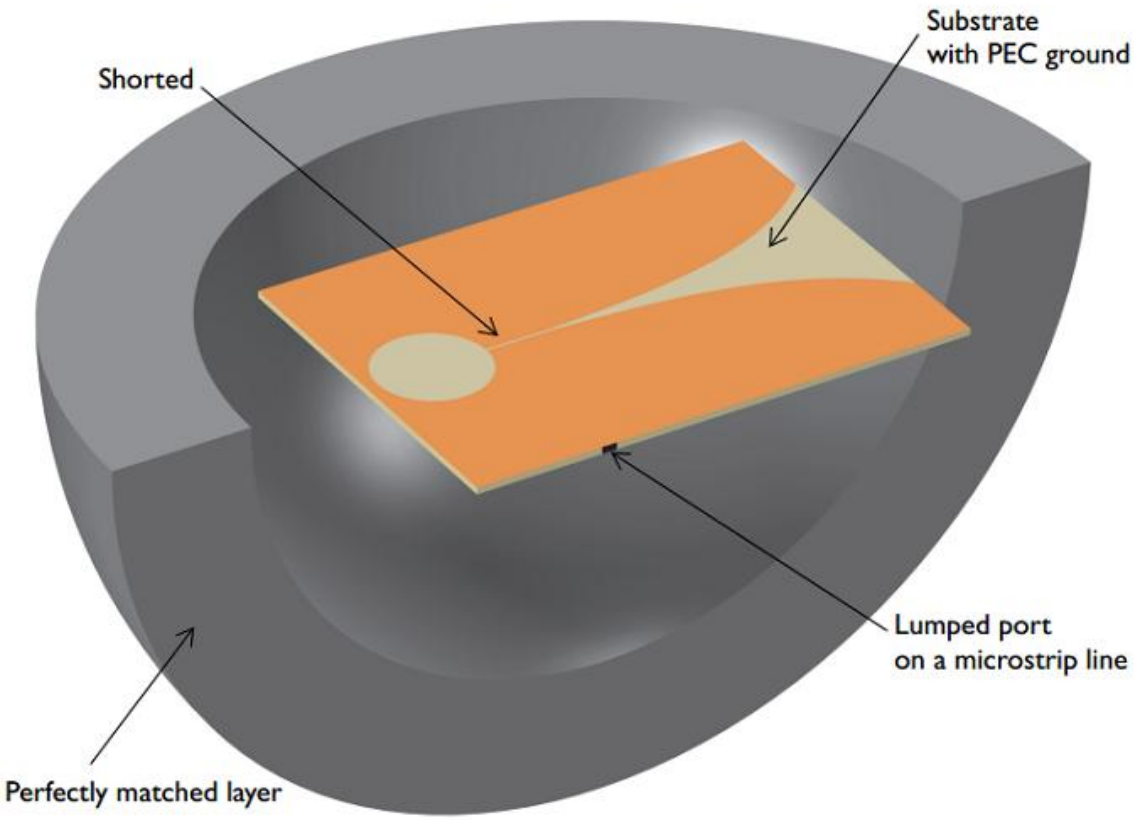
(i) Simulation of different Patterns using COMSOL Multiphysics

(ii) Parametric studies on the proposed structures.

(iii)Design of the structure.

(iv) Testing of results.

4. VIVALDI ANTENNA STRUCTURE :



DESIGNING PARAMETER

General parameters that are used during the design of Vivaldi Table 1.1 Parameters Values Antenna.

Parameters :

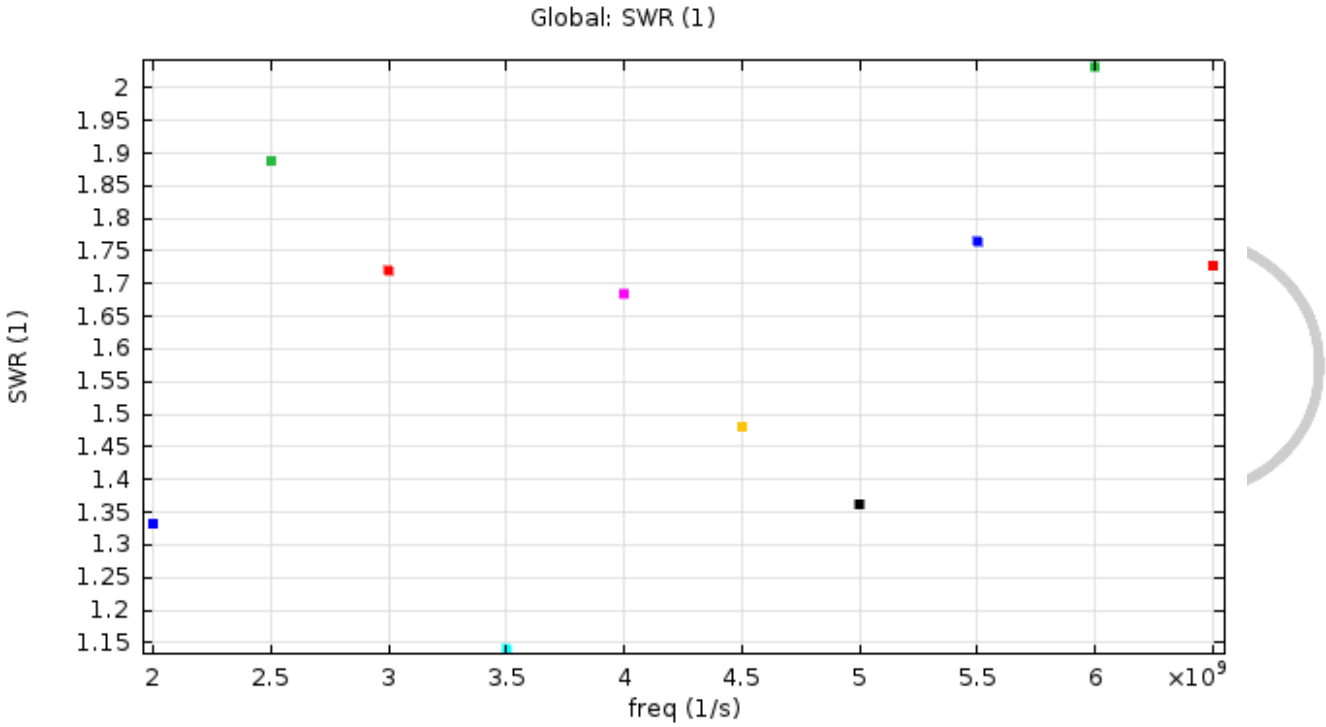
Name	Expression	Value	Description
W-slot	0.5 [mm]	5.000E-4 m	Slot width
Thickness	60 [mil]	0.0015240 m	Substrate thickness
F –max	6.0[GHz]	6.0000E9 Hz	Maximum Frequency in sweep
F-min	2.0[Ghz]	2.0000E9Hz	Minimum frequency in sweep
F0	F-max	6.5000E9 Hz	Current frequency in sweep

Length	110[mm]	011000 m	Length of antenna
Radius	10 [mm]	0.012000 m	Radius of circular slot
Width	80 [mm]	0.080000 m	Width of antenna
Dielectric	3.38	33800	Dielectric constant of substrate

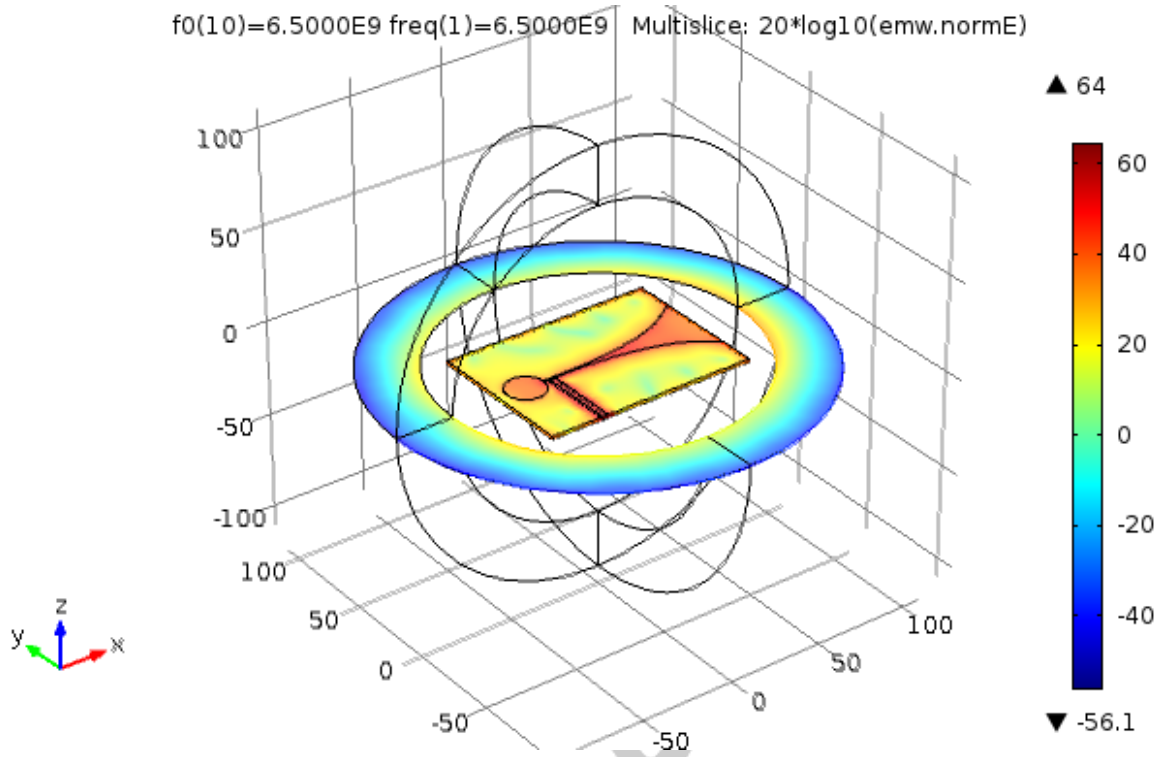
TABLE 1

SIMULATION

solving the antenna model using COMSOL Multiphysics, the results are studied in various forms. The SWR plot and electric field plot reveals that the model have good. shown in figure 5.2.



SWR Plot fig 1.1



Electric-filed plot of Vivaldi Antenna

Discussion of Results

At 3.5 GHz the SWR obtained is 1.15 . which results in a electric field of 64 . The all result are plotted on frequency range of 2GHz to 6GHz.

Comparison …….

Parameter	Preexisting design antenna	Proposed design antenna
Radius	12	10
SWR	3.5	3
Electric field	62.7	64

CONCLUSION The proposed Vivaldi antenna is simulated using the COMSOL .This report presents the design and detailed results of the Vivaldi Antenna with the selection of FR4 substrate material. This antenna is showing good performance at a frequency of 3.5 GHz .

The proposed antenna is capable of switching between three different band of 3.5 and 4.5 to5.

This Allows their use in various communication purpose and medical applications .

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