

Performance Evaluation of High Bandwidth Vivaldi Antenna using HFSS

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Abstract – A Simulation of a Vivaldi antenna for ultra-wide band applications is presented in this paper. Vivaldi antenna also known as tapered slot antenna belongs to the end fire travelling wave antennas. It consist of a symmetrically etched slot in the ground plane with a dielectric substrate placed over it. This antenna operates in large frequency range and is of low cost. An antenna with length and width of 50mm*68.5mm is designed and simulated. A satisfactory gain of 6.7 dB with a large bandwidth of 2.6-9.3 GHz using HFSS 14.0 version is obtained.

Keywords – Tapered Slot Antenna, Travelling Wave Antenna, Ultra Wide Band, Vivaldi Antenna.

I. INTRODUCTION

The rapid advancement in wireless communication system is placing increasing demand on systems performance and its functionality. A wide research is being done to integrate multiple systems operating at different bands in to an ultra-wide band system. Considerable performance is observed using tapered slot antenna. Its adaptability for wide-band and wide scan arrays make it a prime candidate for high performance phased array systems [1].

Tapered slot antenna (TSA), also known as Vivaldi antenna was first brought out by Gibson in 1979 [2]. Vivaldi antenna is a member of aperiodic, continuously scaled, gradually curved, slow leaky end-fire travelling wave antennas. TSA consists of an exponentially tapered flare, different parts of the antenna radiate for different frequencies, while the size of the radiating part is constant in wavelength. Theoretically, the TSA has an infinitely wide operating frequency band but practically it is limited due to certain practical factors like feed to slot line transition, finite dimensions of the antenna, etc. However, the Vivaldi antenna can still provide multi-octave operation and is designated an UWB antenna. These type of antennas are widely used in microwave imaging, radar systems and wide-band phased array systems, all of which has a requirement to know the radiation characteristics and phase centre location.

In this paper a tapered slot antenna has been designed and analysed. Its characteristics are studied using the full wave simulation tool HFSS, and the simulated results show's different characteristic performance of the tapered slot antenna.

II. DESIGN

The proposed antenna design is made of two parts: radiator - the part of antenna body-shape responsible for

creating radiation by the currents flowing through it, and matching - the part of antenna which makes impedance transition from radiator to the system impedance for what antenna is designed. Radiator part can also be treated as a matching between transmission line and the free space. [3]

Various simulation software's are available for antenna design, one such advanced software is HFSS, used for the design of the antenna. The name HFSS stands for high frequency structure simulator. Ansoft HFSS is a tool of choice for high productivity research, development and virtual prototyping. The antenna parameters can be optimized in the software using the parametric optimization tool.[4-5]

With reference to Fig.1, R is defined as the opening rate, the points $P_1(z_1, y_1)$ and $P_2(z_2, y_2)$ are the two end points of the taper profile. It can be observed that P_1 is actually the point where the slotline starts to flare after a short of uniform line from the cavity. The difference between the points $z_2 - z_1$ is the flare length L, d mentions the whole length of the antenna and H stands for the exponential flare width.

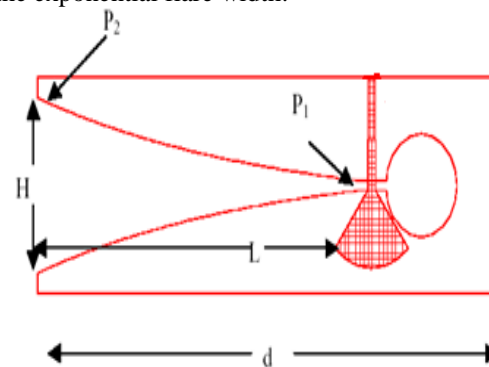


Fig.1. structure of the Vivaldi antenna

The exponential curves used to develop the taper profile can be defined by using the following equations [6]

$$Y = C_1 e^{Rz} + C_2$$

Where

$$C_1 = \frac{y_2 - y_1}{e^{Rz_2} - e^{Rz_1}}$$

$$C_2 = \frac{y_1 e^{Rz_2} - y_2 e^{Rz_1}}{e^{Rz_2} - e^{Rz_1}}$$

III. RESULTS

The tapered slot along with its ground plane are etched on one side of the layer of the dielectric substrate, while the microstrip line and its fan shaped open stub are printed on the other side of the layer. The antenna is

designed using a dielectric substrate of thickness 1.5mm with a dielectric constant of 2.65, the microstrip line is designed with width 4.045mm, and the fan shaped open stub with a radius of 7.7mm with an angle of 100.7° . The slot line starts at the circular slot having a radius of profile is developed from the equation $Y=0.3 \cdot \exp^{0.09(x-25)}$.

For the designed antenna the following results are achieved with a peak gain of 6.7dB in the frequency range of 2.6-9.3GHz

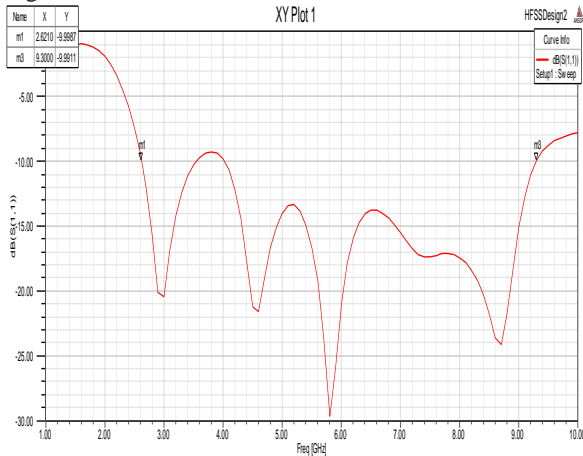


Fig.: Return loss

The above fig.2 shows the return loss for our design and has achieved a high peak at 30 dB

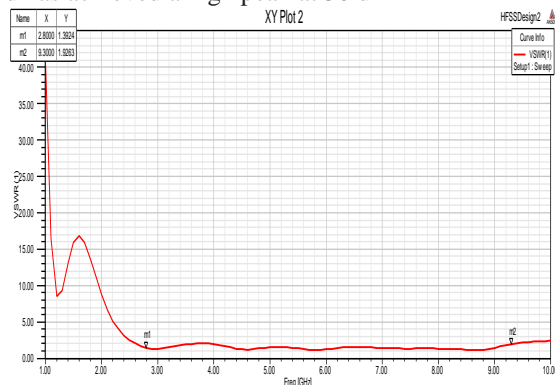


Fig.3. VSWR

The above fig.3 shows the vswr graph and it can be seen that it is between one and two for the desired frequencies

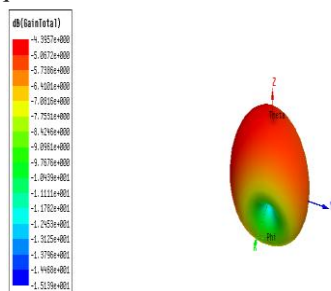


Fig.4. 3D Polar Plot

The above fig.4 shows the 3D polar plot.

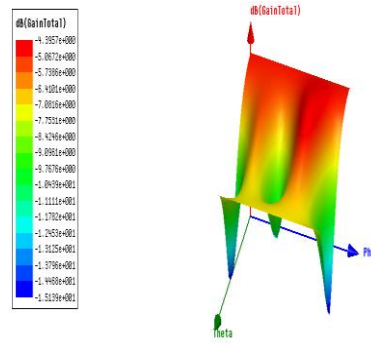


Fig.5. 3D Rectangular Plot

The above fig.5 gives the 3D Rectangular plot.

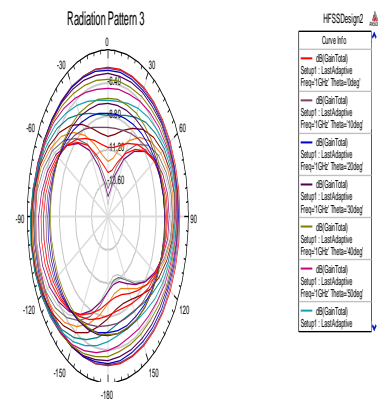


Fig.6. Radiation Pattern

The above Fig.6 shows the radiation pattern for all the frequencies.

IV. CONCLUSION

The designed antenna can be used in the ultra-wide band frequency range from 2.6-9.3GHz. It exhibits a vswr of less than 2.0 and a peak gain of 6.7dB in a frequency range from 2-9GHz. due to its small size it can be used in various applications. The dimensions of the antenna has been reduced which enhanced the gain and return loss of the antenna.

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