

Design and Simulation of Half Vivaldi & Full Vivaldi Antenna for Mobile Applications

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Abstract :-

Compact Vivaldi patch antenna with a parasitic meander line is presented in this paper. There are two configuration of Vivaldi antenna is presented. One is half Vivaldi antenna and another one is full Vivaldi antenna. Vivaldi antennas can be made for linear polarized waves or using two devices arranged in orthogonal direction – for transmitting / receiving both polarization orientations. This antenna is suitable for portable DVB-T which extended from 450 MHz to 850 MHz receiver applications and the WLAN (Wireless Local Area Network) IEEE 802.11b,g (5.1–5.8) GHz frequency bands and WiMAX band (3.3–3.8) GHz. The measured reflection coefficient of the proposed antenna is compared with the simulated one; good agreement is observed. Also, simulated radiation pattern of the antenna is presented. All simulations are carried out using the EM commercial simulator, high frequency structuresimulator(HFSS)ver.13

Keywords: HFSS, Full Vivaldi, Half Vivaldi, Return Loss, Gain

INTRODUCTION

The rapid developments in broadband wireless communications and the great number of commercial and military applications necessitate new types of antennas which can support higher bit rates. 4G mobile terminals are gaining immense popularity thanks to their advanced and user-friendly features. Also, designing new compact antennas with good characteristics applied for 3G mobile terminals is quite necessary although number of similar studies had been conducted so far. According to the federal communication commission (FCC) UWB rulings the signal is recognized as UWB if the signal frequency band is from 3.1 GHz to 10.6 GHz or the signal bandwidth is more than 500 MHz.

An exponentially tapered slot antenna (ETSA) suitable for packaging and integration with other components is introduced and proposed for the UWB range with gain more than 5 dBi and reflection coefficient below -6 dB which represents VSWR <3 for the whole frequency range. The ETSA is a variation of the Vivaldi antenna, with the outer edge exponentially

tapered, and it was introduced for the first time in. The design and performance characteristics of the ETSA are investigated in .

Microstrip antennas have some attractive advantages such as small volume, very low-profile, light weight, easy fabrication, and constant directional radiation patterns, which have been widely used in designing miniaturized antennas. Since the development of tapered slot technology, many traditional antennas could be made into corresponding printed antennas, such as printed Vivaldi antennas and printed log-periodic dipole antennas. Figure1 shows the geometry of the proposed antenna.

A Vivaldi antenna is a co-planar broadband-antenna, which is made from a dielectric plate metalized on both sides. The feeding line excites a circular space via a microstrip line, terminated with a sector-shaped area. From the circular resonant area the energy reaches an exponential pattern via a symmetrical slot line. Vivaldi antennas can be made for waves or using two devices arranged in orthogonal direction for transmitting receiving both polarization orientations. If fed with 90-

degree phase-shifted signals, orthogonal devices can transmit/receive circular-oriented electromagnetic waves. The Vivaldi antenna also demonstrates good performance, such as wide band and symmetric E- and H-plane beam patterns. The antenna was first proposed in [7]. Since then some advances have been made. In designs, full-wave numerical techniques and simulation tools are used to analyze the antenna. In applications, Vivaldi arrays were built for radar applications [8], wireless communications applications [9], and dual polarization applications [10]. Those multifunction applications are the current trends. The linearly polarized antenna shows good performance: reflection coefficient better than < -6 dB and gain between 2.53 and 3.48 dBi over the operating bandwidth in the DVB-T band and about 4.4 dBi in the WLAN band. This antenna has an end-fire radiation pattern when the parasitic element is disconnected and omniradiation pattern when the parasitic element is connected [11].

The rest of the paper is organized as follows. Section II & III outlines the complete design of the proposed Full Vivaldi and Half Vivaldi antenna. Measured and simulated results of the proposed antenna are discussed in Section IV. The conclusions are given in Section V.

Half Vivaldi and Full Vivaldi Antenna

An FR-4 substrate with 4.4 and thickness 0.81 mm was used in this design.

In order to design a compact wideband antenna, a tapered slot antenna has been considered as starting point. The selected profile was a Vivaldi antenna [9]. The expression used to obtain the profile is the following:

$$z(x) = C_1 e^{C_2 x} + C_3$$

Where $C_1 = 0.02$, $C_2 = 0.71$, and $C_3 = 0$

This model (complete Vivaldi) has $100 \times 125 \times 0.81$ of

height and width respectively, and the geometry of this antenna is shown in Fig. 1(a). The antenna is printed on a FR4 substrate of thickness 0.81 mm, which will be employed later for fabrication. Fig. 2 shows the simulated reflection coefficient obtained for this design, which can be optimized to cover a large bandwidth [6].

In order to reduce the size, a monopole version (half Vivaldi) was considered, as shown in Fig. 1. As observed, the vertical

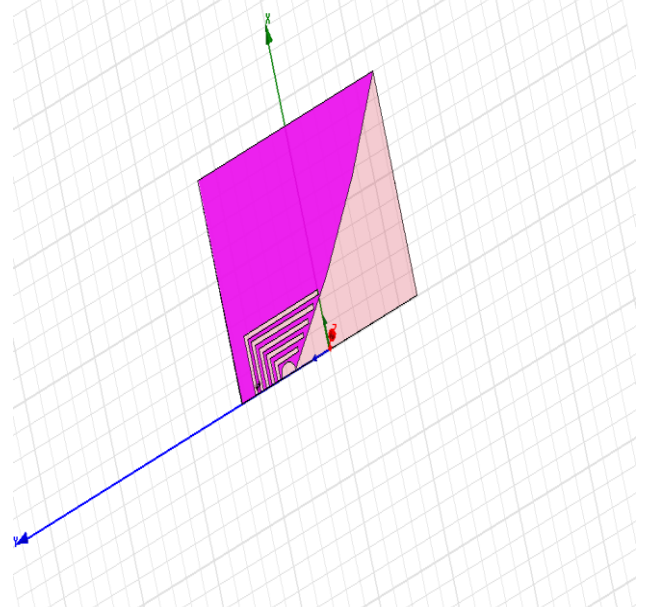


Fig 1. Top View of Half Vivaldi Antenna

The proposed antenna is compared with Half Vivaldi patch antenna as shown in Fig. 2. Square Slots are cut into the ground plane with 2mm distance apart.

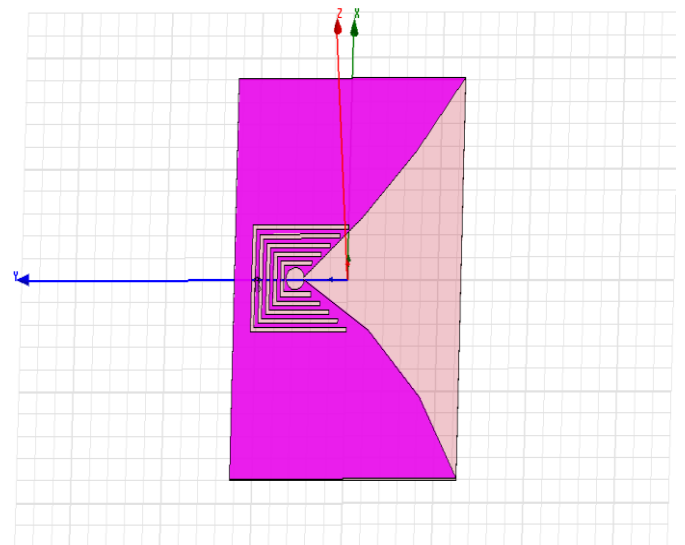


Fig 3. Top View of Full Vivaldi Antenna

Return Loss is an important parameter for an antenna design. The ideal return loss is assumed to be -10 dB. Return loss should be minimum. The antenna is simulated in HFSS tool and return loss is measured. In case of Half Vivaldi return loss is -15.6334 dB. The return loss of Half Vivaldi is given by Fig. 4. This graph shows that for low frequency analysis, the antenna gives narrow

bandwidth performance and for high frequency analysis, antenna gives wide bandwidth.

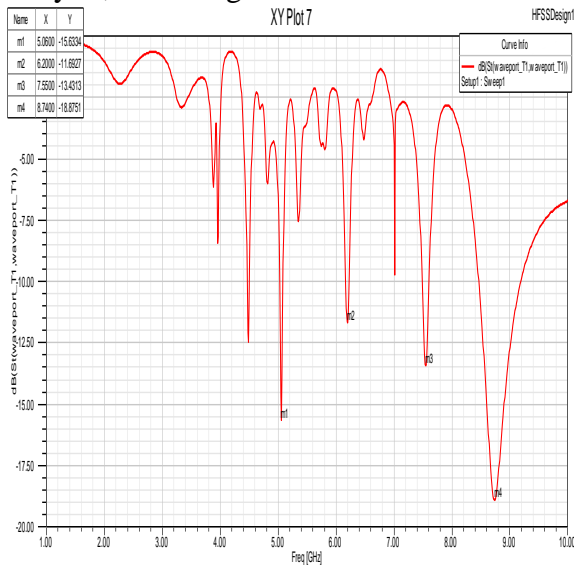


Fig 4. Return Loss of Half Vivaldi Antenna
 In case of Full Vivaldi return loss is -28.1105 db. The return loss of SSRR is given by fig 4. This graphs shows that return loss becomes more negative as compared to half Vivaldi antenna.

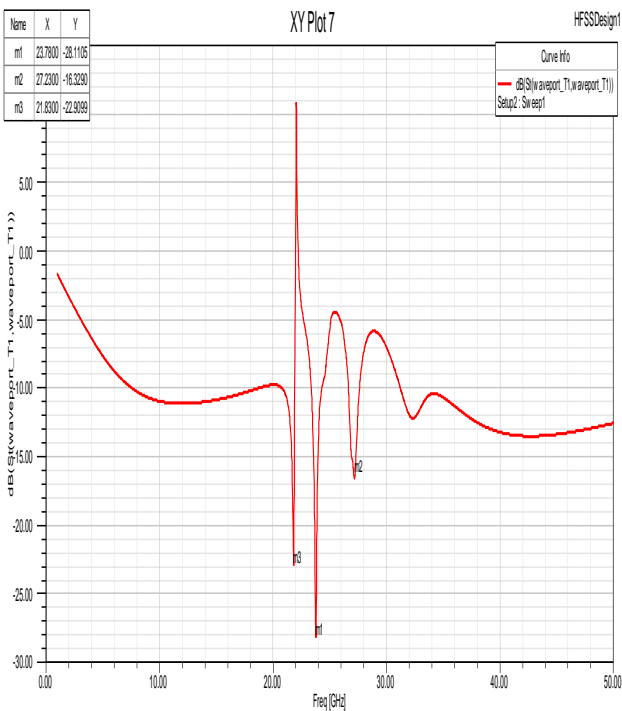


Fig 5. Return Loss of Full Vivaldi Antenna
 The current distribution gives an idea to distribute a charge to the whole surface. The distributed current is gives in ampere per meter. In case of Half Vivaldi current distribution is given as 9.4107 ampere per m^2 . Current distribution of Half Vivaldi is shown in fig 6.

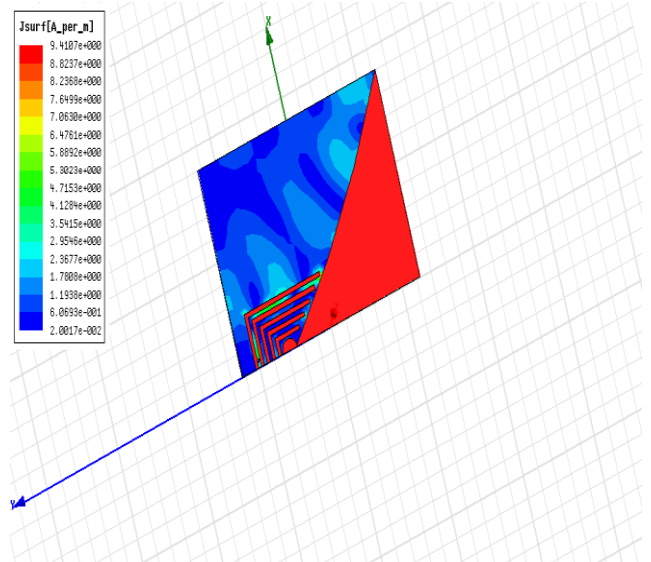


Fig 6. Current Distribution of Half Vivaldi Antenna

The current distribution is improved in Full Vivaldi. The distributed current is gives in ampere per meter. In case of Full Vivaldi current distribution is given as $6.6133e^{+002}$ ampere per m^2 . Current distribution of Full Vivaldi is shown in fig 7.

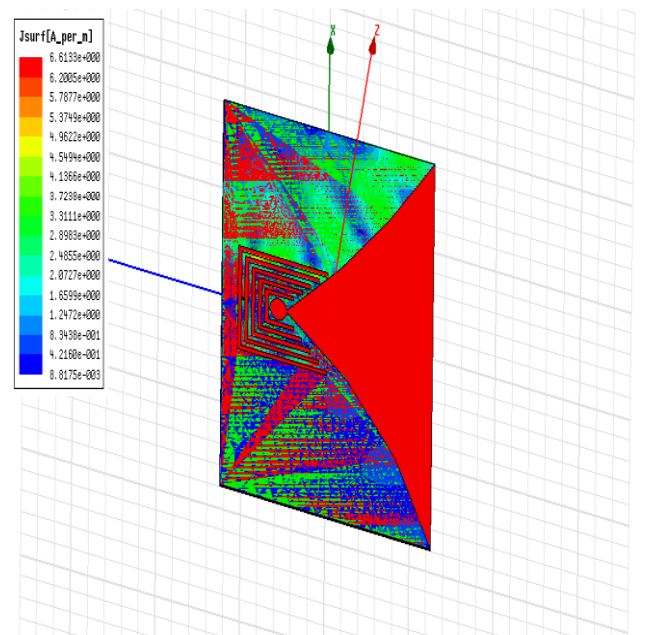


Fig 7. Current Distribution of Full Vivaldi Antenna

Gain is also an important parameter to design an antenna. The Gain enhanced by drawing different slots. Radiation pattern of gain given in fig 8. Gain of Half Vivaldi antenna is 4.3610 db

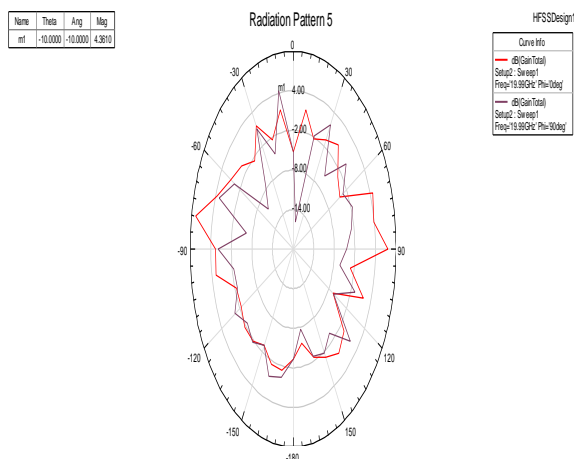


Fig 8. Radiation Pattern of Gain of Half Vivaldi Antenna

Gain is improved with full slots. Radiation pattern of gain given in fig 9. Gain of Full Vivaldi is 12.4607 db.

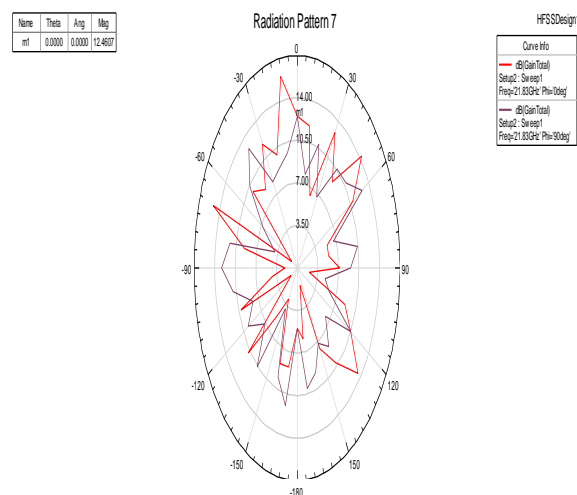


Fig 9. Radiation Pattern of Gain of Full Vivaldi Antenna

Comparative Analysis

In this section, comparative of two configurations is shown in tabular form. Return loss and bandwidth is compared in table 1.

| Sr. No | Parameter | Half Vivaldi Antenna | Full Vivaldi Antenna |
|--------|-------------|----------------------|----------------------|
| 1. | Return Loss | -15.6334 | -28.1105 |
| 2. | Gain | 4.3610 | 12.4607 |

Table 1. Comparative analysis of two configurations of Antenna

IV. Conclusion

After Simulation, it is found that half Vivaldi patch antenna has low return loss with high gain and bandwidth. Simulated return loss is -28.1105 with gain 12.4607 db for mobile applications.

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