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DESIGN & ANALYSIS OF CORRUGATED HIGH GAIN DUAL BAND VIVALDI ANTENNA FOR VEHICULAR WIRELESS COMMUNICATION

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ABSTRACT

High gain corrugated Vivaldi antenna with end fire radiation patterns is presented for WLAN applications. The antenna is operated for frequency 2.2-2.5GHz with 310MHz bandwidth and 5.2-5.5GHz and is designed on low cost FR4 substrate of thickness 6mm. 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 corrugations 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 bandwidth significantly along with increased gain. The proposed antenna shows nearly stable end-fire radiation patterns with 8dB gain throughout the frequency range. In addition, effects of corrugated slot in ground and adding more parasitic element to improve gain are examined and discussed in detail. The radiation pattern, directivity, return loss, VSWR and Bandwidth of the proposed antenna are described and simulated using FEKO software.

Keywords: Corrugated, End Fire, High Directivity, Tapered Slot (UWB), Vivaldi Antenna.

I. INTRODUCTION

All automobile manufacturers continue to incorporate more and more technological features into their vehicles. One of the features is wireless access. Adaptive, multiband, low-cost, and ultralow-profile antennas are on high demand for several wireless communication and sensor network applications. The automotive industry is progressively adopting wireless solution to help the development of new applications and services. The performances of the antenna mounted on the vehicle are crucial to the overall system robustness of a dynamic communication system. Enabling safety in vehicles is an ongoing challenge for the automotive sector. In order to reduce the co-channel interference and multipath effects of wireless communication systems, directional antennas must be implemented. Omni directional antennas limit the capacity for vehicular communications. A Vivaldi antenna is a co-planar broadband-antenna, which is made from a dielectric plate metalized on both sides. It is a traveling-wave endfire planar antenna featuring wide bandwidth. It is a directional antenna. Vivaldi antennas are known as Exponentially Tapered Slot Antennas (ETSA). The TSA uses a slot line etched on a dielectric material, which is widening through its length to produce an endfire radiation.

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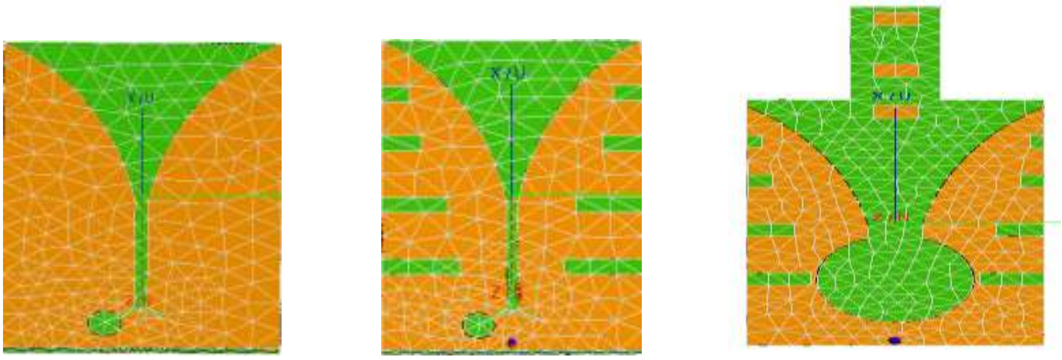
Exponentially Tapered slot antennas (Vivaldi antenna) have been widely used in phased and active arrays for radar systems. They are good candidates for multifunction communication applications because of their stable directional patterns and consistent impedance matching over a very broad operating frequency range without any tuning elements as well as low profile and unobtrusive planar structures. Therefore, they have been proposed for emerging UWB wireless communications and radar applications.

II. VIVALDI ANTENNA GEOMETRY AND DESIGN

The Vivaldi antenna is a traveling-wave endfire planar antenna featuring wide bandwidth. However, the directivity of a conventional Vivaldi antenna is low. An improved Vivaldi antenna is proposed to develop a novel Vivaldi antenna with high directivity in an ultra wideband. Basic geometry consist of following: Four slots are inserted on both sides of the adjacent metal layer. Three planar directors that slightly increase the dimension of the antenna are employed in the aperture of the tapered radiating slot.The Y-Y transition between the unbalanced microstrip line and the balanced slot line is adopted.The slotline with a circular slotline open circuit is cut in the ground plane of the microstrip line with short circuit at the end of one of its branches. Three different cases are presented here. They are simulated using CADFEKO software.



Case 1 Case 2 Case 3

Fig.1 Simulated Antennas

Case 1 denotes Vivaldi tapered slot antenna, Case 2 denotes Vivaldi tapered slot corrugated antenna whereas Case 3 is an Vivaldi tapered slot corrugated parasitic antenna with three planar directors. The directors helps to improve the directivity and the energy in endfire direction.

III. RESULTS & ANALYSIS

The antenna was simulated using electromagnetic solver FEKO. This proposed antenna is designed for 2.2-2.5GHz WLAN and 5.2-5.5GHz. The choice of dielectric substrate plays an important role in the design and simulation of the microstrip transmission line as well as any other antennas. The dielectric substrate used here for designing is Perfect electric conductor. In this paper the simulated results for three different cases discussed above as shown in fig.1 are shown below. The reflection coefficient is the most important parameter of an antenna.It indicates how much power is reflected back by the antenna. Fig.2 shows the combined result of reflection coefficient for three diffent cases having centre frequency 2.45GHz. The graph shows that reflection coefficient ≤ -10dB for all the cases. Fig.3 shows that VSWR remains below 2 for all the different cases. Fig.4

illustrates the radiation pattern for different cases which shows that the antenna fulfils the broad band characteristics. Fig. 5 shows the simulated gain at 2.45GHz. It can be seen that an improved Vivaldi antenna with corrugated parasitic geometry has higher directivity than the conventional one i.e. Case 1. Simulated current distribution at 2.45GHz as sown in Fig.7 shows the concentration of current around the slots of Case 3. This proves that to obtain the broadband characteristics for vehicular wireless communications with high directivity the Vivaldi antenna shown in Case 3 is the best option and also further modifications can make the antenna to work for multiple frequency bands.

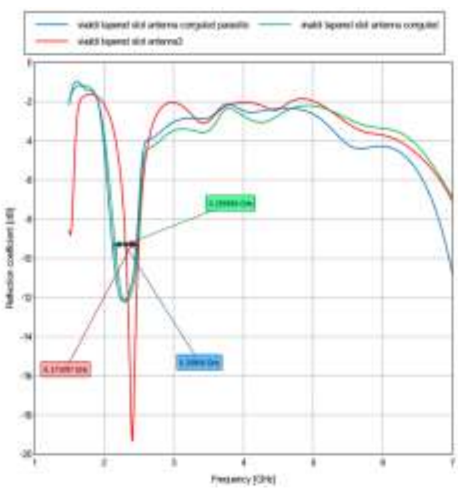


Fig.2 Reflection coefficients of simulated antennas for three different cases

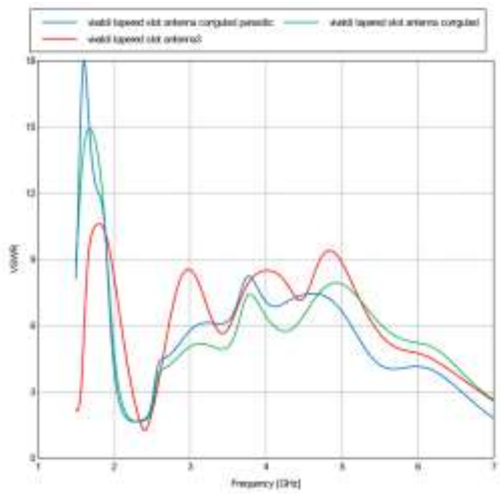


Fig.3 VSWR of simulated antennas

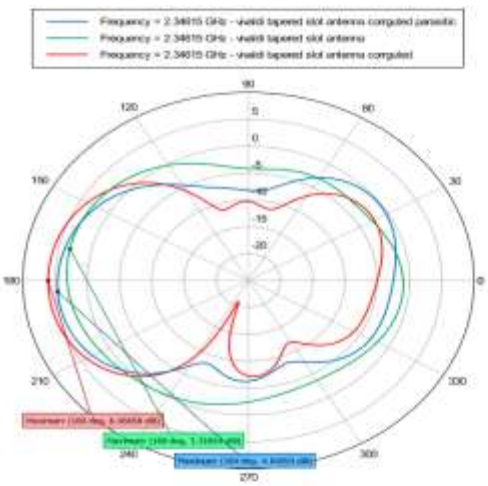


Fig.4 Simulated radiation patterns for three different cases

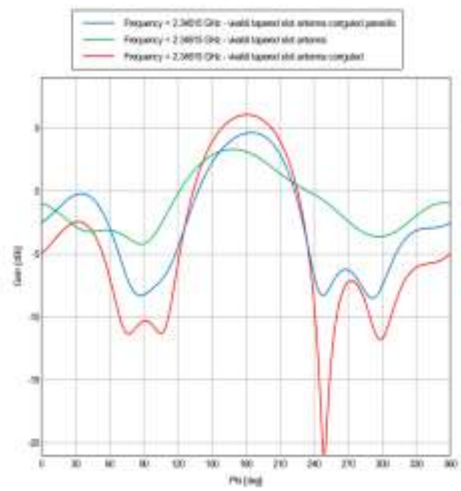
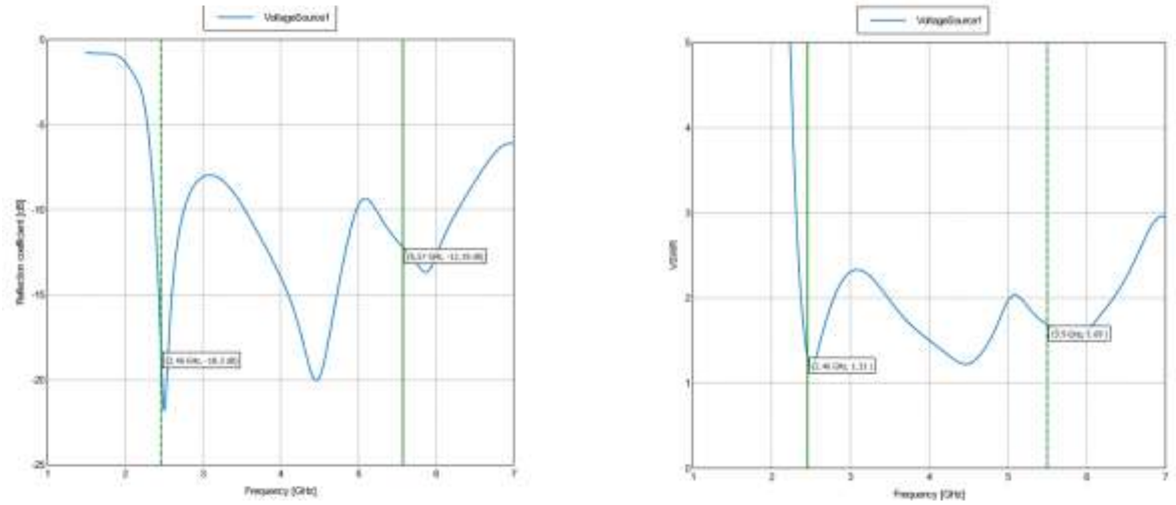


Fig. 5 Simulated gains of three different cases

The results for second frequency band i.e. 5.5GHz for the Case 3 is shown in Fig.6 below and it is found to be as per desired for better performance of antenna. VSWR is found to be below 2 for both the frequency band.



(a)Simulated Reflection coefficient at 2.46GHz & 5.57GHz (b)Simulated VSWR at 2.46GHz & 5.57 GHz

Fig.6 Simulated results for Case3 at 2.45GHz & 5.57GHz

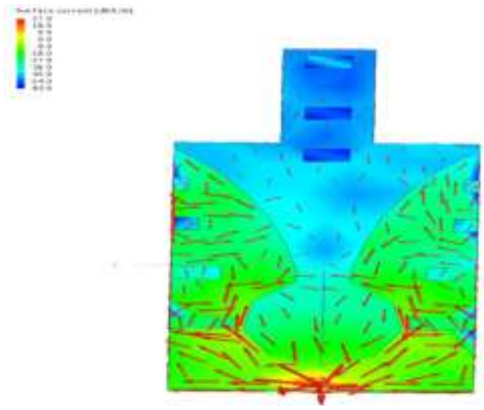


Fig. 7 Simulated surface current distribution for Case 3

IV. CONCLUSION

A high gain Vivaldi antenna (Case-3) has been proposed in this paper for WLAN application in Vehicular wireless communications and radar applications. The design and analysis of corrugated Vivaldi antenna using a parasitic element is achieved and we have observed its return loss, VSWR and radiation pattern at 2.4 GHz & 5.57 GHz. It is clear that Vivaldi antenna gives a good end-fire radiation with 8 db gain and an impressive 13%bandwidth using the corrugated slot. The proposed antenna covers the WLAN band 2.4-2.48 and and has more than 10% of fractional bandwidth (from 2.2GHz to 2.5GHz).The proposed antenna can be used in high range radar applications when used in array configuration and is a good candidate for microwave imaging applications also.

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