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Compact and Low Profile Antenna for Satellite Digital Audio Radio Application

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ABSTRACT

Modern vehicles are having number of electronic gadgets inbuilt, which giving safety, luxury and comfort with entertainment. Most of the vehicles are having sophisticated entertainment devices with the advancements in the technology. The satellite digital audio radio service provides the high entertainment through high-fidelity audio network from the satellite to the passengers in the vehicles. Satellite data for entertainment like news, weather reports, traffic information and music will be available through monthly subscription to the users. A compact and low profile antenna was designed to receive these signals for providing digital audio radio entertainment in the vehicles. The antenna output parameters and its radiation pattern are presented in this paper.

Keywords: *Low Profile, Digital Audio Radio, Compactness.*

INTRODUCTION

Today's production vehicles are fitted with a multitude of antennas to facilitate communication and enable a moving vehicle to connect with the outside world. Recent years have seen the introduction of new electronic devices to the automotive environment. These devices are usually designed to aid the driver, increase safety, or enhance the driving experience, and many of them rely on wireless communication to perform their task. Antennas are a necessary part of any wireless communication system, enabling transmission and reception of signals in free-space [1-4].

At the same time, automobile manufacturers have been seeking to create cost effective, fuel efficient vehicles with attractive styling. This leads to a focus on sleek, lightweight vehicles with reduced aerodynamic drag and improved styling - an emphasis that would naturally conflict with fitment of traditional antennas. These market preferences, along with the technological factors, have combined in the past few years to drive significant innovation in the world of vehicular antennas.

In previous decades the use of antennas in vehicles was primarily limited to those employed for AM and FM radio. In contrast, today's vehicles are often fitted with many antennas for additional purposes such as remote keyless entry, satellite navigation and others. In the future it is likely that vehicles will require still more antennas for such things as mobile internet and mobile video, collision avoidance radar, and vehicle-to-vehicle or vehicle-to infrastructure communication[5-8]. The Satellite Digital Audio Radio service delivers hundreds of additional radio stations and is implemented by using circularly polarized signals from satellites arranged in an orbit which dwells over the North American continent. In urban environments where buildings can cause multipath and shadowing of the satellites, terrestrial based transmitters are also used.

Figure (1) Shark fin antenna model placed on car

Many varieties of shark-fin antennas exist, having been popularized primarily by the European marquees near the turn of the 21st century. Shark-fin antennas are commonly a collection of several antennas. Most designs consist of multiple narrowband antennas all located together under a single radome or housing. This housing is typically shaped like a blade or dorsal fin, and is usually located on the roof towards the rear of the vehicle [9-10].

RESULTS AND DISCUSSION

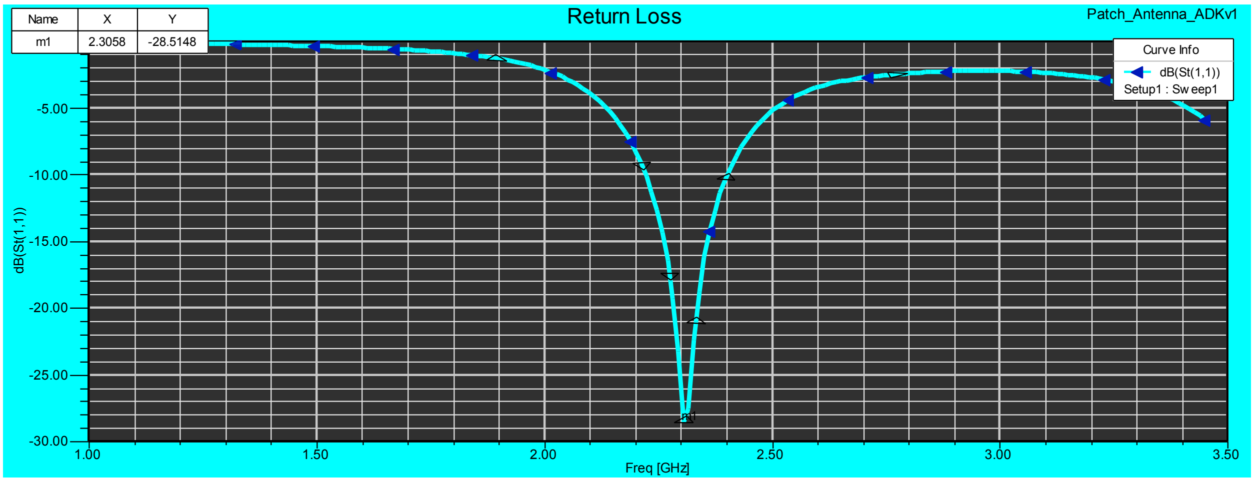

Figure (2) Return loss Vs Frequency

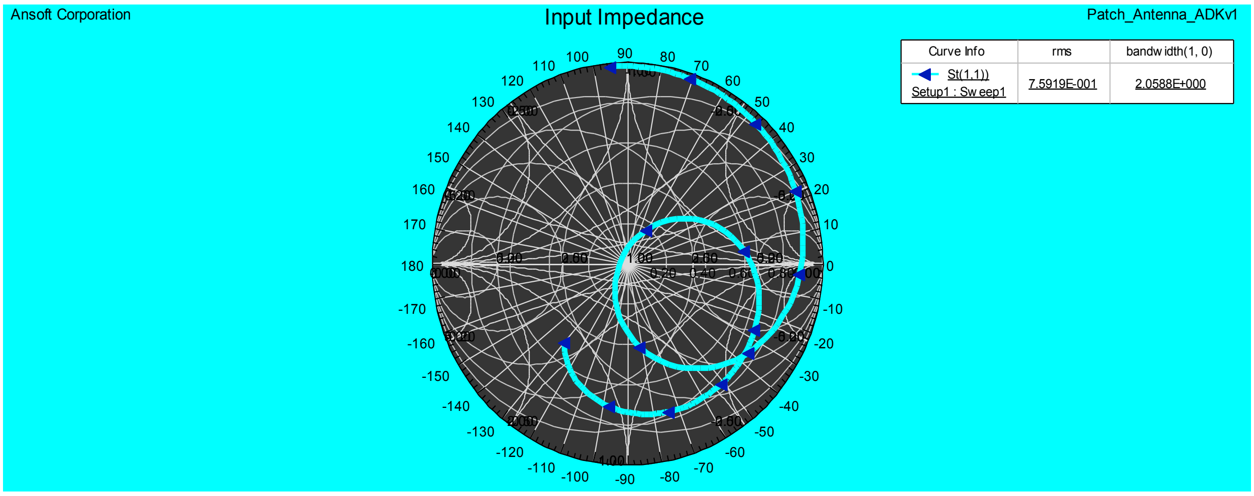

Figure (3) Smith chart

The main purpose of this antenna is to capture the audio signal at desired frequency. From the return loss curve we got the value of return loss -28.51dB at 2.3 GHz. This is showing excellent value of return loss <-10dB at desired frequency.

The input impedance of an antenna is critical to achieve proper matching to the transmitting device to which it is attached. Most transmission lines have an impedance of 50Ω, while the impedance of an antenna changes with frequency. At some frequencies a given antenna will not be matched to the transmission line, and will not accept or radiate power, while at those frequencies where the antenna is designed to operate, the impedance of the antenna will allow the electromagnetic energy to pass into the structure and radiate into the surrounding space. Figure (3) shows the input impedance smith chart for the current antenna. This antenna is showing rms of 7.59 and impedance bandwidth of 0.89%. Two measures are stating the impedance matching are commonly used, both of which are based on the reflection coefficient, which is a measure of how much energy is reflected back into the source from the antenna's terminals. First method is from reflection coefficient and second from VSWR. This antenna is having both the results at above the satisfactory levels.

In many wireless systems an antenna is designed to enhance radiation in one direction while minimizing radiation in other directions. This is achieved by increasing the directivity of the antenna which leads to gain in a particular direction. The gain is thus "the ratio of the radiation intensity, in a given direction, to the radiation intensity that would be obtained if the power accepted by the antenna were radiated isotropically" (that is, equally in all directions). In the case of a receiving antenna, an increase in gain produces increased sensitivity to signals coming from one direction with the corollary of a degree of rejection to signals coming from other directions. Antenna gain is often related to the gain of an isotropic radiator, resulting in units dBi.

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Figure (4) 3D gain

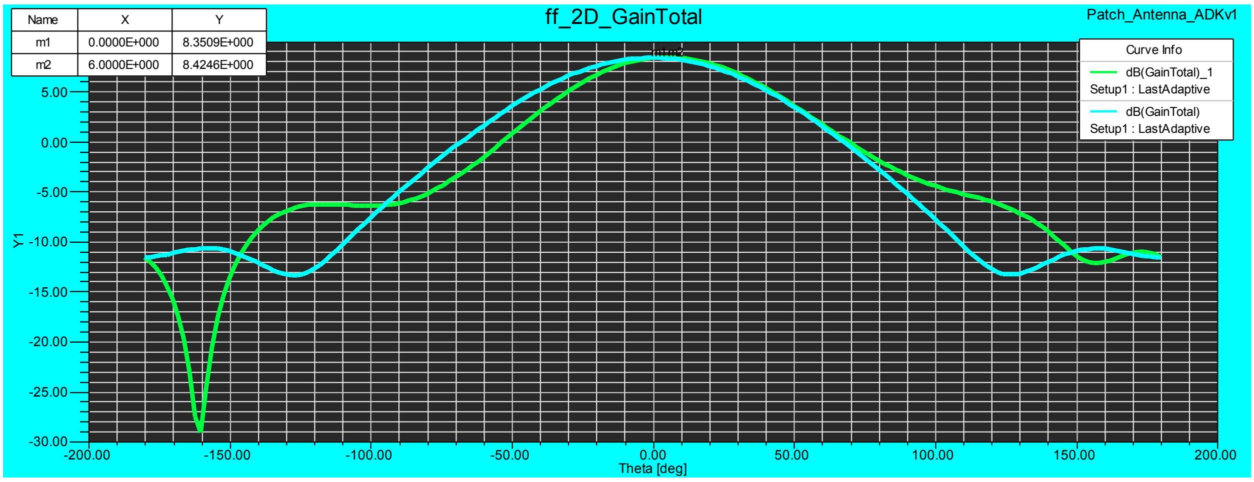
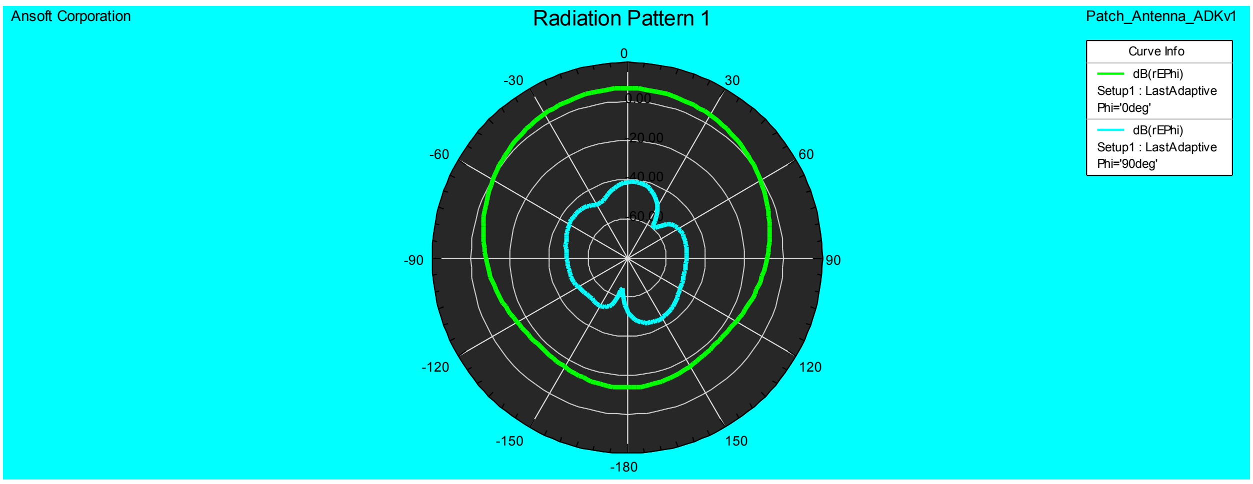


Figure (5) 2D gain

The radiation pattern is a graphical depiction of the relative field strength transmitted from or received by the antenna. Antenna radiation patterns are taken at one frequency, one polarization, and one plane cut. The patterns are usually presented in polar or rectilinear form with a dB strength scale. Radiation pattern of the current antenna in phi direction is shown in figure (6).

From the figure (6) it may be observed that the magnitude of the radiation is non-directional in the azimuth (around the sides) but not in elevation (sweeping from high to low).



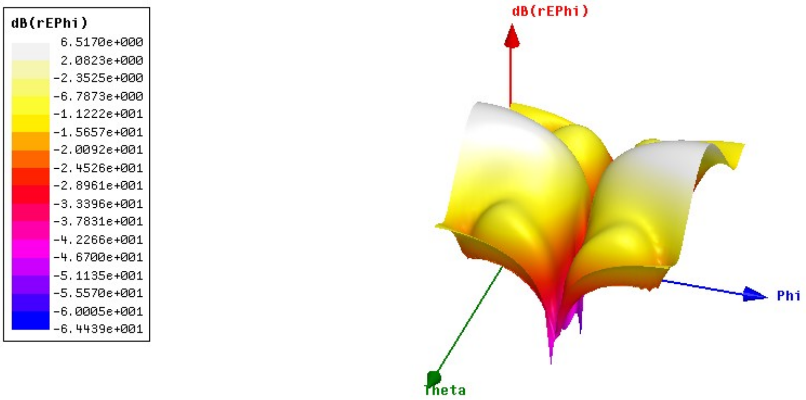


Figure (6) Radiation pattern at phi in polar and 3D Rectangular form

The radiation of the antenna is expressed in terms of the field strength E (in V/m), and then the graphical representation is called field strength pattern or field radiation pattern. Similarly if the radiation of the antenna is expressed in terms of the power per unit solid angle, then the graphical representation is called power radiation pattern. Figure (6) shows the radiation pattern in theta direction in polar and 3D Rectangular coordinates.

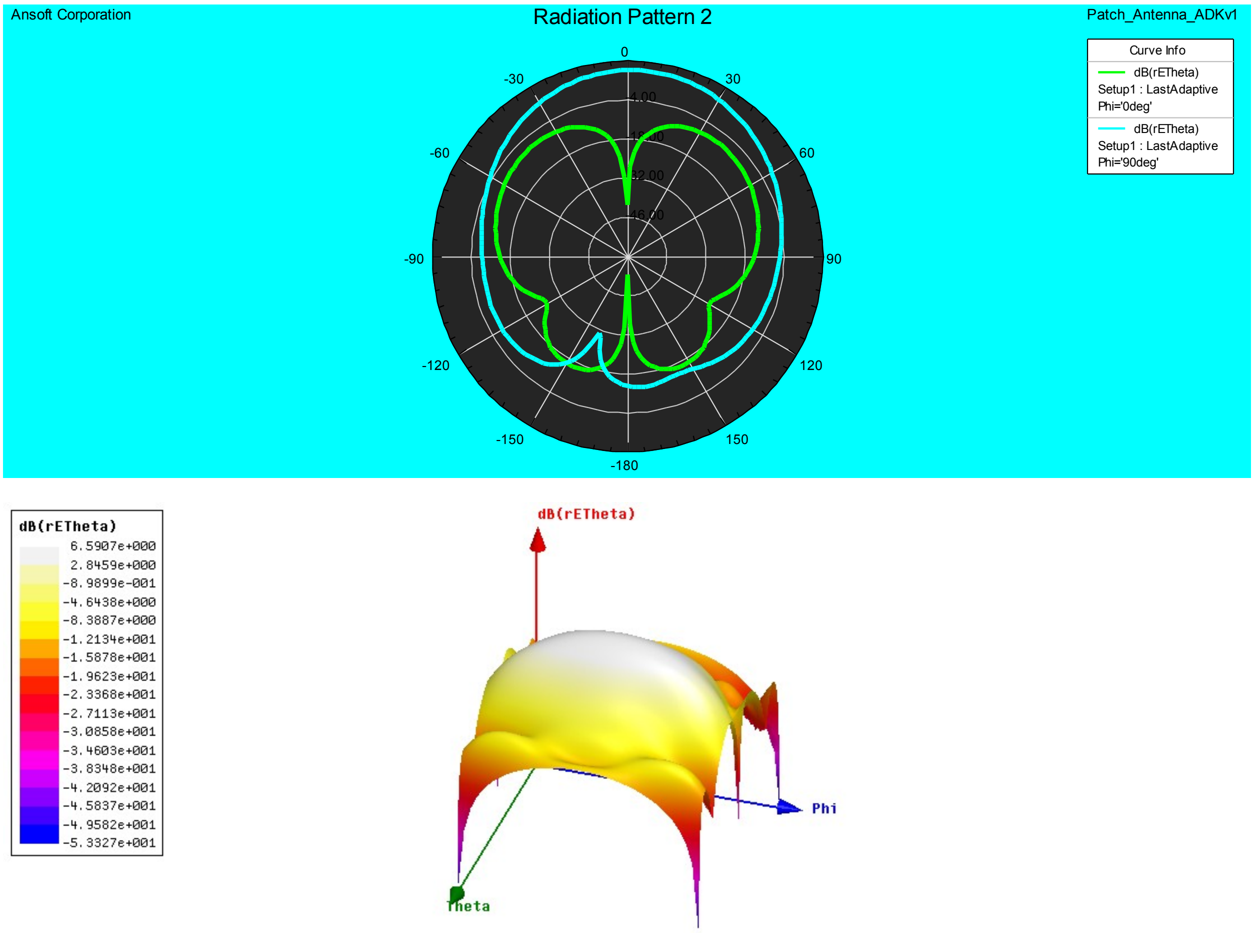


Figure (6) Radiation pattern at theta in polar and 3D Rectangular form

CONCLUSION

Automotive antennas have seen significant advancements in recent years. As seen from the antenna configuration and simulation, a good impedance match is obtained at the desired frequency. Also, depending on the frequency allotted the acceptable gains and directivities are achieved. These acceptable results will give encouragement for the deployment of a new range and type of integrated vehicular antennas. Future developments will likely focus on two key areas like further integration of the antenna components with the vehicle structure, and new antenna configurations for radar and vehicle-to-vehicle communication services. This antenna design is giving excellent results and motivation to design antennas for advanced communication devices in various applications.

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