

Design and Analysis of Dipole and Monopole Antenna for CUBESAT Application

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Abstract: For several years, most of antenna such as a simple dipole or monopole receives vertically polarized signals and re-radiates it with horizontal polarization, or vice-versa. The mode of converting antenna can be utilized in the in-line mode or in the reflection mode. Testing is conducted within ranging frequency and analyses are done due to their performances mainly on losses, radio gain and directivity. Due to that gap, this research will explore the development to construct a simple dipole and monopole by a running an antenna simulation system. The output will be used to compute the radio performances where both transmitting and receiving antennas are both polarized vertically. Some analyses are discussed accordingly to this conventional method.

Keywords: Antenna, cubesat, dipole, monopole, satellite

INTRODUCTION

Apparently, the dipole antenna and its variations have been extensively used in the field of wireless communication for its simple geometry and reliability. In addition when the antenna is vertically mounted, the dipole antenna features an omnidirectional radiation pattern, making it useful for terrestrial applications, non-line-of sight conditions and situations where transceiver modules are often deployed randomly (Mandeep *et al.*, 2010a; Mandeep *et al.*, 2010b).

For near ground wave propagation applications where both the transmitting and receiving antennas are placed near the surface of the earth, it is shown that propagation path loss for vertically oriented antennas is by many magnitudes lower than any other antenna orientation configuration (Mandeep and Hilary, 2011). For air or ground vehicle applications it is highly desirable to use low-profile antennas that can produce vertical polarization with omnidirectional radiation pattern. Also applications such as network of unattended ground sensors, low-profile antennas are highly desired (Singh and Loke, 2011). Whereby, monopoles that emulate virtually identical performance behavior as that of a dipole antenna are often used at lower frequencies.

Therefore, a further analysis is needed to be carried out to find out their performances especially when two identical dipoles or monopoles antennas are placed vertically and measured with free loss or perfect ground plane are taken into consideration (Mandeep, 2010a).

The dipole and monopole antenna is perhaps one of the most fundamental and commonly used antennas nowadays due to its simple geometry and reliability. Much research has been done with implementing different polarization to transmit and receive antennas. From the testing and analyses that have been conducted, few advantages and disadvantages discussed in lieu of that (Mandeep, 2010b). This shows that the developed antenna is antennas have always a bi-directional receiving behavior like a classical dipole antenna. The design antenna is of wideband, low mutual coupling, high gain and compact.

MATERIALS AND METHODS

In this design, a combination of one VHF and one UHF permission to use two different antennas at the same time. Both of these antennas had been placed at different position to determine the interaction between them and position them so that it may minimize the interference.

Firstly, two antennas is placed orthogonal each other to minimize the interaction between them. Three different cases for 353 mm UHF dipole and 610 mm VHF monopole are examined. The VHF monopole is placed at corner to simplify deployment and the UHF dipole is moved at three different positions. The distances between the antennas are 8, 6 and 4 cm, respectively. From the simulation, it shows a better performance for each antenna in term of gain, S11 and S21 when the antennas are far from one to another. The

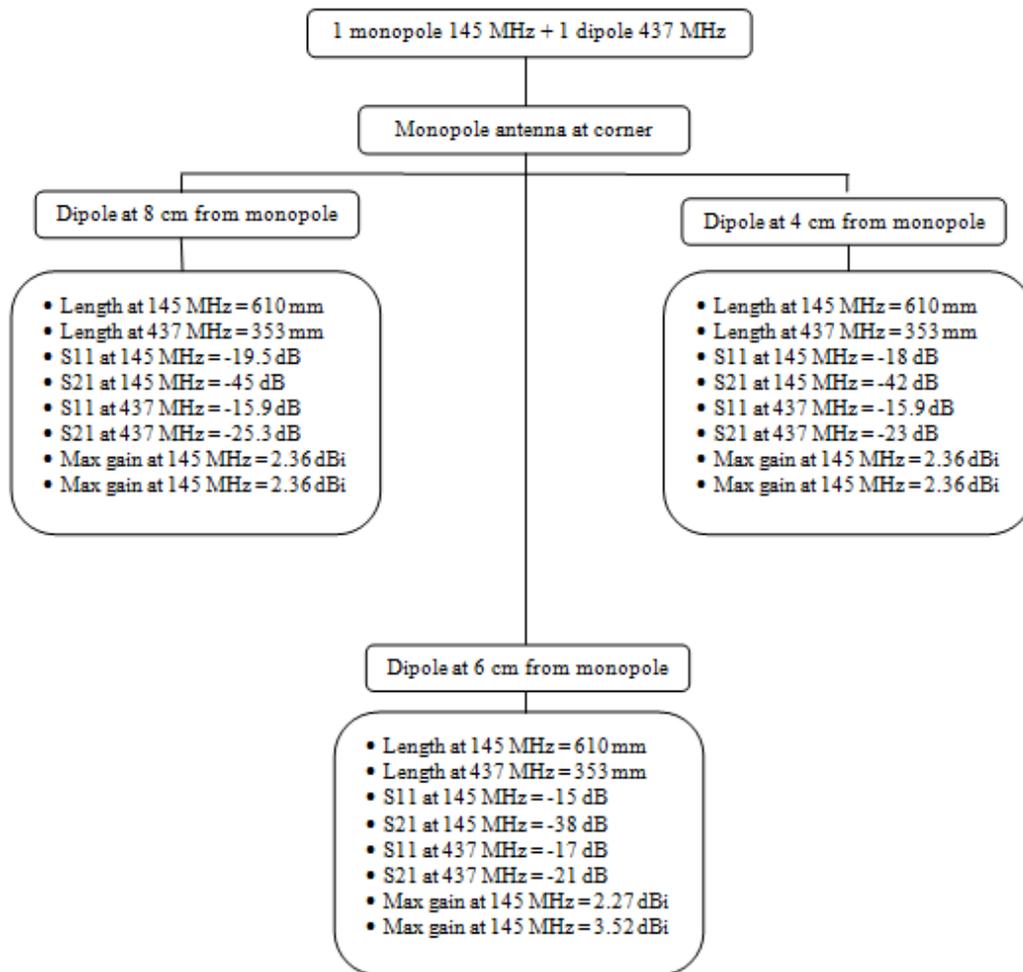


Fig. 1: UHF dipole with VHF monopole at corner

UHF antenna doesn't have much impact on the VHF antenna while the VHF monopole has a real influence on UHF antenna. The radiation pattern of VHF antenna is looked regular like when the VHF antenna is alone. Meanwhile, the radiation pattern of UHF antenna is malformed and maximum gains are increases in the first two designs compared to when UHF dipole alone but decreases when there is only 6 mm between the antennas. Figure 1 summarized these three designs.

Secondly, the VHF monopole is placed at the edge center and UHF is placed at three different distances as in previously. The results show the S21 is low in each situation and decreases lightly from 60 to 50 dB. For UHF antenna, the gain is better if the antenna is very close to 6 mm or very far from the VHF antenna. Figure 2 summarized all the three designs.

RESULTS AND DISCUSSION

Some comparisons have been done to ensure good and imperative design is produced. Firstly, the

advantages and disadvantages of monopole and dipole antenna are revised. For monopole, the advantages are it gives less weight and length compared to dipole. It is easier to be deployed as it not required a balun for symmetric excitation as dipole. Besides, the space for mounting the monopole is less than a dipole. However, the only drawback of monopole is it produced minimum signal in antenna axis. On the other hands, the dipole antenna is good in producing two elements geometry which able to attenuate the minimum signal. As summarized explanation above, finally a design with a VHF quarter wavelength monopole antenna at 145 MHz and a UHF half wavelength dipole antenna as illustrated in Fig. 3 is recommended for this cube satellite application. As to gain the best performance, the antennas should be in parallel to the earth's surface. In a way to attenuate the minimum at the center of radiation pattern, it is ensuring the angle between the elements of the UHF dipole antenna is 1200 and inverse the VHF and UHF antenna as shown in Fig. 4. The S parameter for UHF dipole and VHF monopole antenna

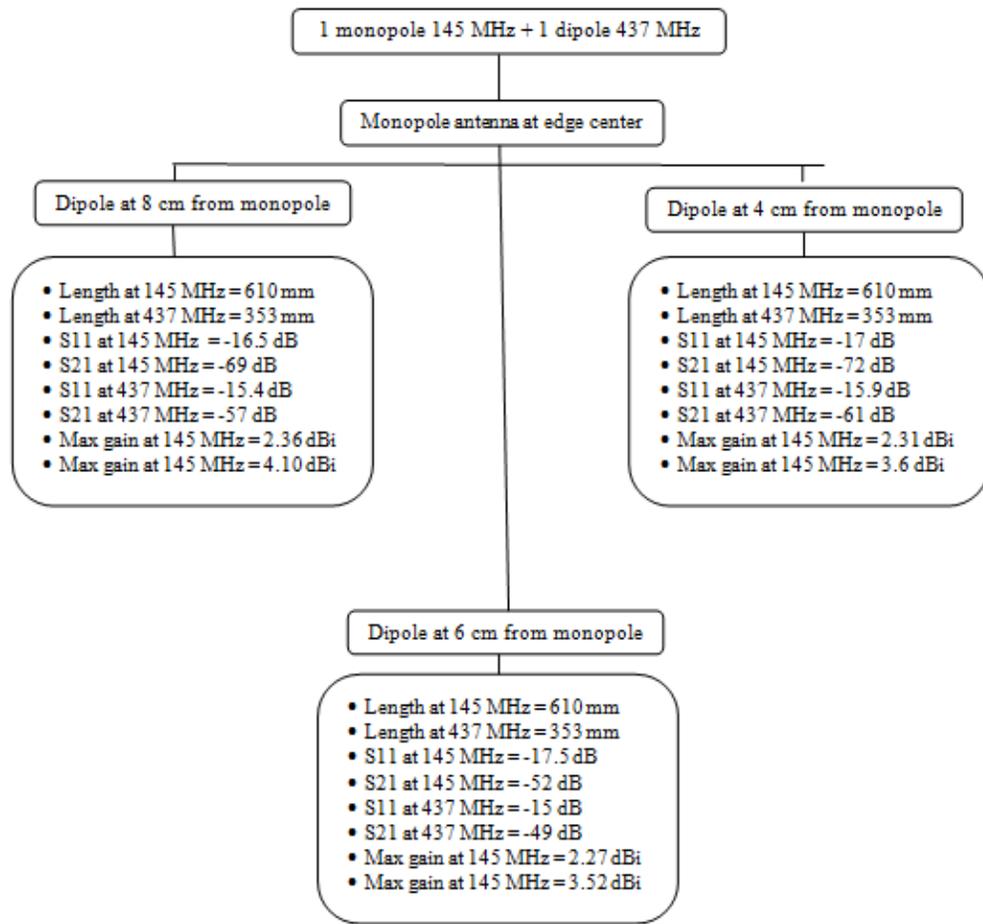


Fig. 2: UHF dipole with VHF monopole at edge center

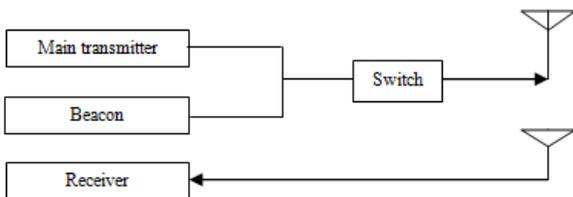


Fig. 3: Block diagram for proposed design

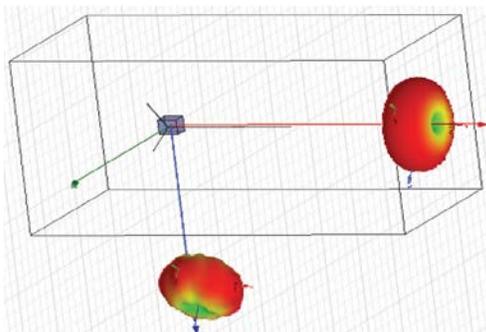


Fig. 4: UHF dipole with 1200 pointed to earth's center and VHF monopole tangent to earth's surface along z axis

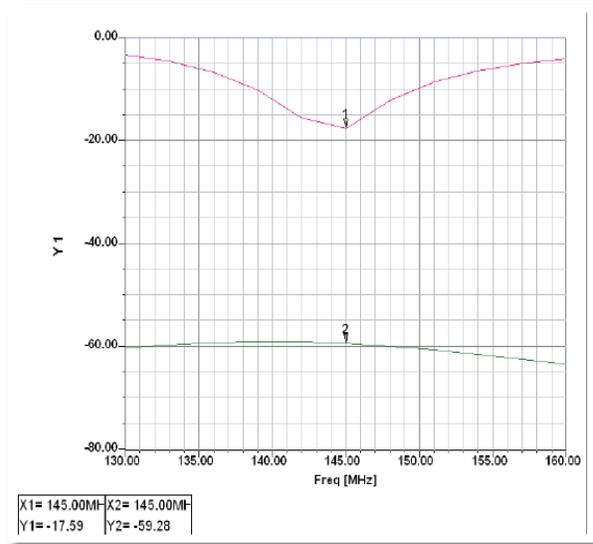


Fig. 5: S-parameters for VHF

are presented in Fig. 5 and 6 respectively. The waveport1 is used for VHF monopole and lumpedport1

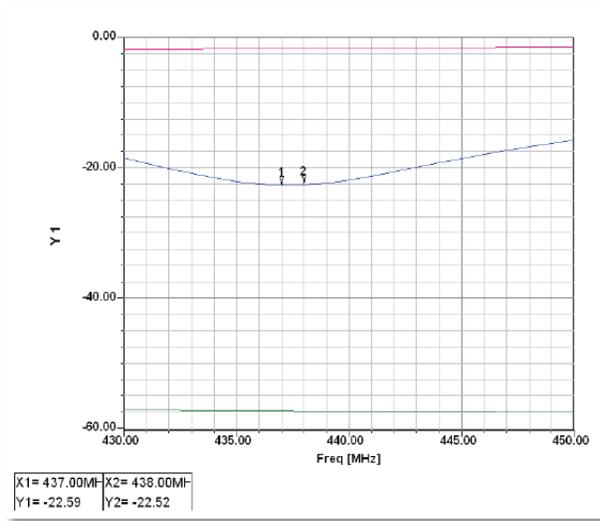


Fig. 6: S-parameters for UHF

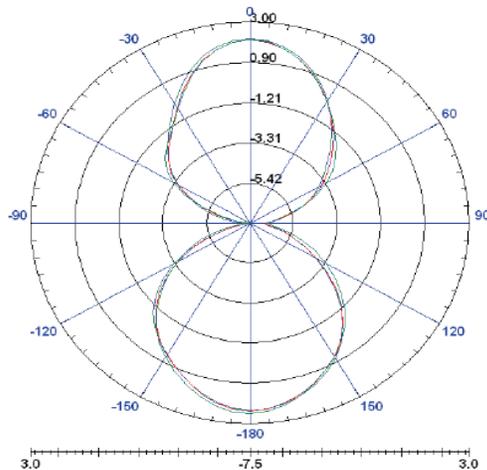


Fig. 7: 2D radiation pattern for UHF dipole

is used for UHF dipole. Meanwhile, the radiation pattern for both UHF and VHF antennas are presented in Fig. 7 and 8 respectively.

CONCLUSION

In this project, the objectives were achieved. Firstly, the dipole and monopole antenna had been designed and simulated using the EZNEC antenna modeling system. In the simulation model, the basic

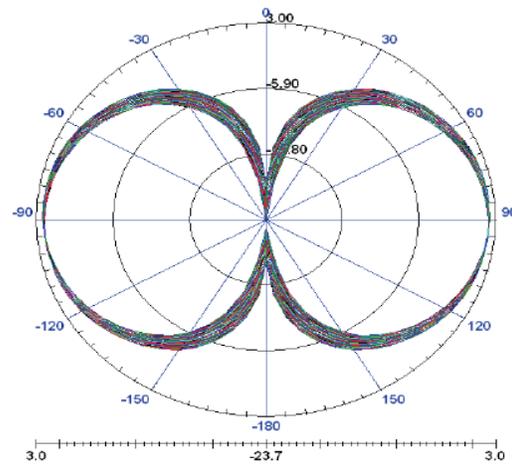


Fig. 8: 2D radiation pattern for VHF dipole

parameters were inserted and produced desired outputs. For example current data, far field pattern data, azimuth and elevation 2D and 3D pattern in free space and over perfect ground, gain, beam width and side lobe reading.

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