DESIGN AND ANALYSIS OF THE CRITICAL PARAMETER OF YAGI ANTENNA FOR KU BAND

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ABSTRACT: This paper presents the design and analysis of Yagi antenna. The proposed antenna is fed by 50 Ohm coaxial connector. The antenna comprises of a dipole, a reflector and several directors. A balun feeding structure is adopted in order to convert from unbalance mode to balance mode and also it is realized the impedance matching. The designed antenna is simulated using High Frequency Structure Simulator (HFSS). The simulation result of return loss is better than -14dB at frequency range of 15.1GHz~16.1GHz. The radiation pattern shows that the antenna has a good radiation characteristics and the antenna gain varies from 10.7 to 11.7 dBi. The critical parameter of antenna is presented and the simulation results has been analyzed.

Keywords: Yagi antenna, balun, Ku band, EM, HFSS.

I.INTRODUCTION

The recent trend on the progress of millimeter wave frequency system and development of its various kind of features . Antenna becomes widely used in wireless communication like Ultra Wide Band (UWB), Wireless Local Area Network (WLAN) etc. The advantages it carries compact size, low cost, high efficiency, light weight easy to design and fabrication. All of these feature makes antenna attractive for many wireless communication application [1]. Yagi-Uda antenna was developed in 1920 and it is known to be the most conventional travelling wave antenna. Yagi-Uda antenna basic structure based on a diapole array with a driver, directors and reflectors also it carries strong directivity and high gain. Therefore it is also widly use in Radar system, television system and communication system [2-3].

A yagi-Uda array antenna also called simple yagi antenna. Which carries driven element composed of typically folded dipole or a dipole and its parasitic parameter known to be an reflector and based on many directors. Yagi-Uda antenna is useful such type of communication where frequencies are very high. We can say that it is used when the range of frequency is greater than 10MHz. Because of this reason it is prominent for amateur radio and it used the band of radio to operators. It has also implication in certain field of satellite communication system. It is rottenly used in communication where frequencies are between 30MHz and 3GHz, or a wavelength between of 10 meters to 10 cm. This is rather impractical as spacing them from the ground by more than half a wavelength is difficult. The lengths of the rod in a Yagi-Uda are almost a half wavelength each, and the spacing between the elements is equal to 1/3 of a wavelength. The Yagi antenna can be used for transmitting or receiving radio signals. As we know that Yagi antenna is a directional and simple to build. Yagi antenna is directional antenna also it carries a standard dipole antenna into different form. Also it utilized single element or a piece of wire. Normally every Yagi antenna has three elements which are consist of dipoles, reflectors and directors. We see that entire television antenna on top of a group of houses, the crossbars of these antennas are pointing in the same direction. This shows that the direction of television transmitter where it is located. Yagi-Uda antenna along the axis are directional and in the plane of elements perpendicular to dipole. From reflector towards the element of driven and reflector. The spacing between elements of Yagi-Uda antenna varies from about 0.1 to 0.25 of a wavelength. This change depends on the specific design. The lengths of the directors are smaller than that of the driven element. The elements of Yagi-Uda antenna which are driven, director and reflector are parallel in one plane, assist on a single crossbar.

Yagi-Uda antenna bandwidth refers to frequency range where its gain of directional and its impedance matching preserved. Basically Yagi-Uda array carries a narrowband and its performance tradeoff at frequency just short value of percentage below to above with design frequency. However the bandwidth substantially can be extended using larger diameter conductors among other technique [4-9].

This research work is organized as follows. Section II briefly describes the antenna design and model structure. The design antenna analysis and simulation result are presented in section III. The conclusions are drawn in section IV.

II. SYSTEM MODEL

The system model can be determined below Fig.1 that the design of yagi-Uda antenna model gain represents by "G" shown below.

$$G=10\times l/\lambda \text{ ------------------- } (1)$$

$$\theta_{3dB}=55\times\sqrt{\lambda/l} \text{ ---------------- } (2)$$

Where G stands for Gain of antenna, l is the length of the antenna, λ is the wavelength in the free space, θ_{3dB} is the beam width of the antenna. Where the Yagi antenna model parameter represents the parameter ranges i-e.

$L\_reflector = (0.5 \sim 0.55)\lambda$,

$S1=(0.15\sim0.25)\lambda$, $r\_dipole=(0.002\sim0.01)\lambda$,

$L\_dipole = (0.45 \sim 0.48)\lambda$, $S = (0.1 \sim 0.4)\lambda$ and .

$L\_director = (0.38 \sim 0.45)\lambda$.

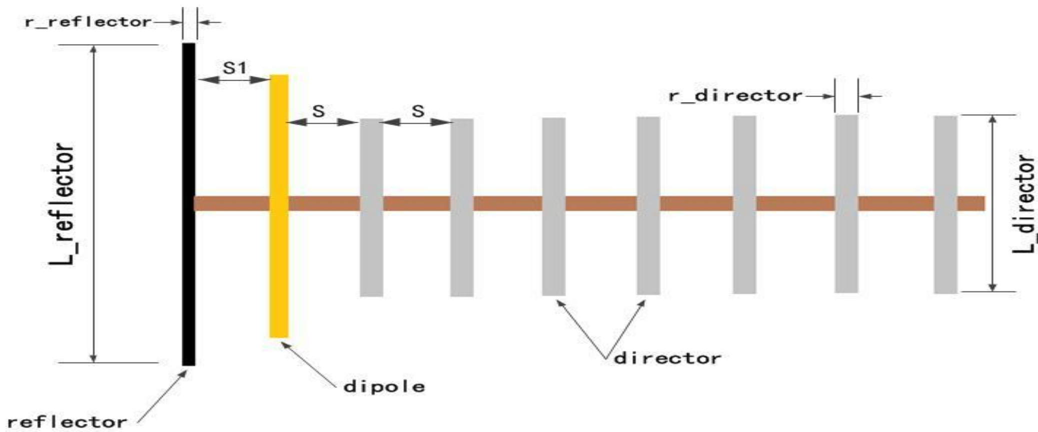

Figure 1. Yagi-Uda antenna model

The antenna is described by specifying the length $L\_director$ of each element and the spacing S between adjacent elements, as is shown in Fig.l. The initial sizes of the antenna can be set according to the empirical equation above. In Yagi antenna the radiation characterstics of diapole part is attached with the diapole antenna. The antenna design of Yagi-Uda based on one reflector, several directors and one driven elements. Reflected waves effects from the load to avoid it the balun impedance technique of matching used. For optimization of the parameter of antenna according to Fig. 1, represents as follows: $L\_reflector$ represents the length of Reflector, L_dipole represents the Length of Driver, $L\_director$ represents the length of director. $S1$ represents the distance between reflector and driver, S represents the distance between first director and driver, $r\_director$ represents the diameter of director, $r\_reflector$ represents the diameter of reflector and r_dipole represents the diameter of dipole

III. SIMULATION RESULTS

The dipole radiates electromagnetic wave, which is reflected by reflector and is directed by director. In the end, the whole antenna radiates forward. The parameters of antenna have a significant impact on results. From Fig.1 it shows that the antenna comprises of a dipole, a reflector and seven directors. Fig. 2, shows a 3D radiation pattern. It demonstrates that the antenna has a good radiating directivity. From Fig 3, we can see that the voltage standing wave ratio is less than 1.5 in the bandwidth from 15GHz to 16.2GHz. From Fig. 3 it shows that , A 2D radiation pattern at center frequency is shown in Fig.4. The 3dB beam width is 37degree the
side lobe magnitude is -12.5dB. From Fig 5. The curve of Gain versus frequency is shown in Fig. 5, it can be seen that the antenna gain varies from 10.7 to 11.7 dBi. From Fig.6. The E_plane and H_plane radiation pattern is shown in Fig.6. The left side one shows E_plane radiation pattern and the right is the H_plane radiation pattern. It can be seen that the E_plane radiation pattern is better than H_plane and from Fig. 7. The Yagi-Uda antenna is a linear polarization antenna from axial radio. We can realize that the axial radio is not upto mark which shows that the antenna has a good linear polarization characteristic.

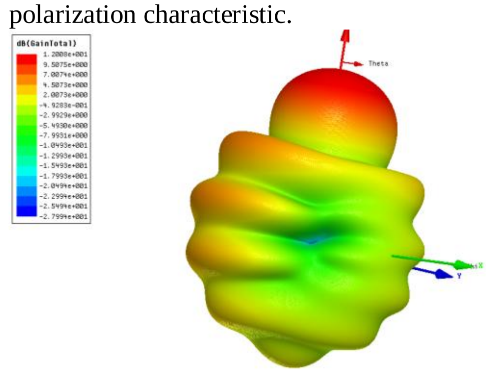

Figure 2. 3D pattern

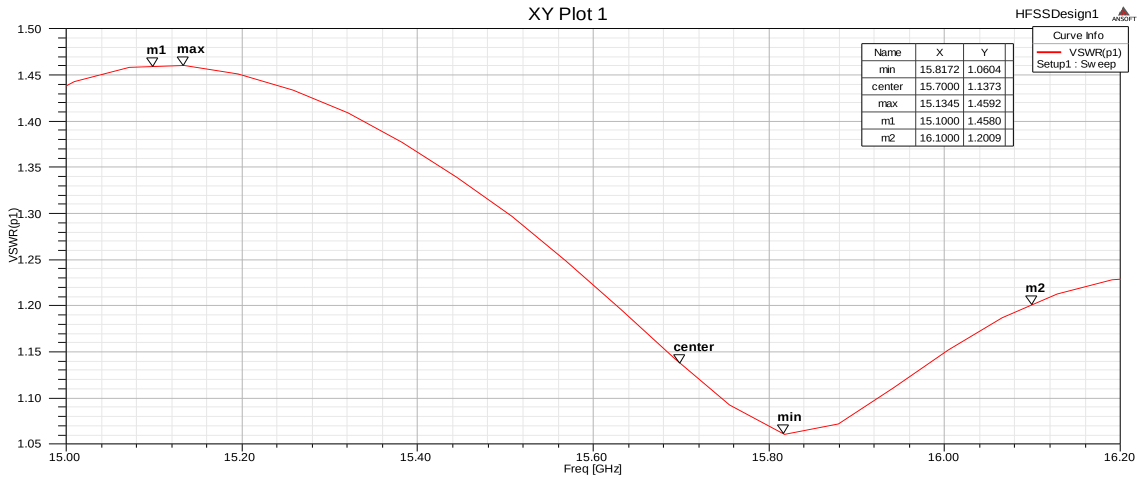

Figure 3. Voltage Standing Wave Ratio (VSWR)

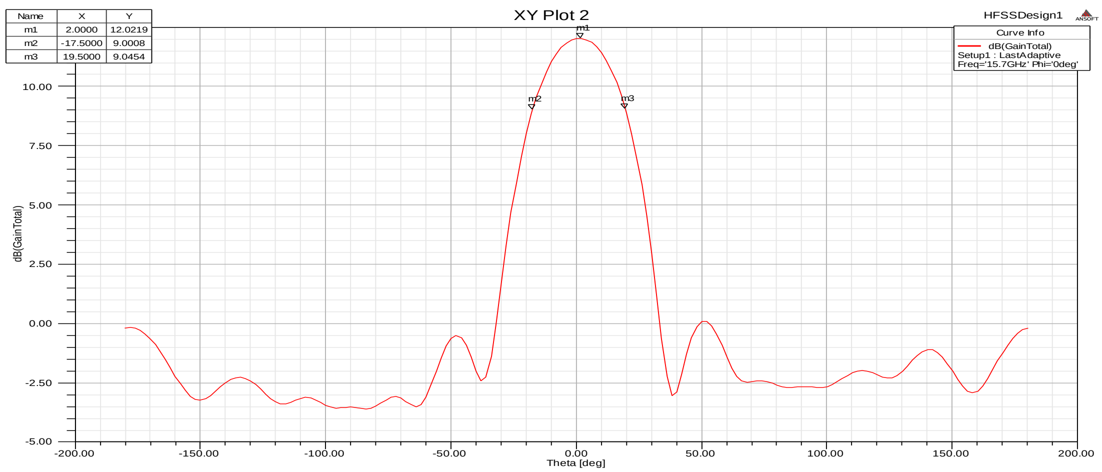

Figure 4. Gain pattern

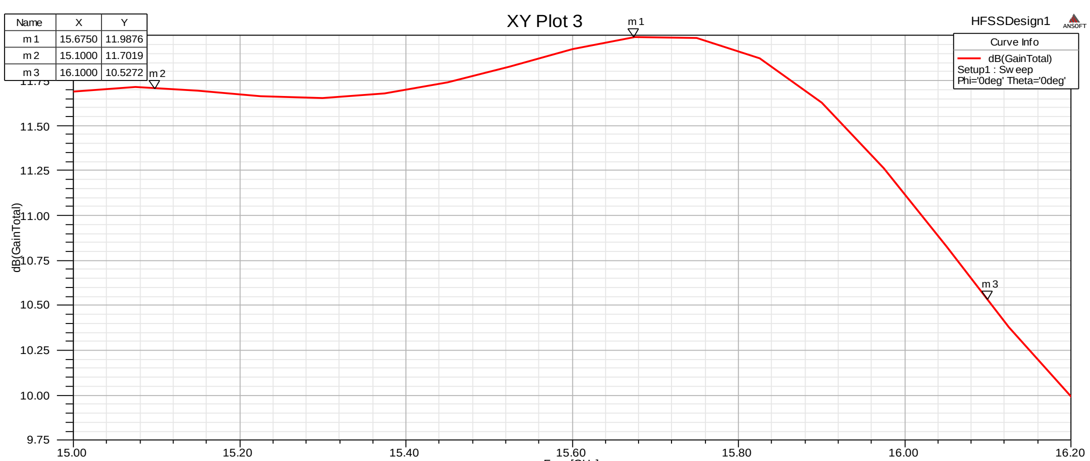

Figure 5. Gain versus frequency

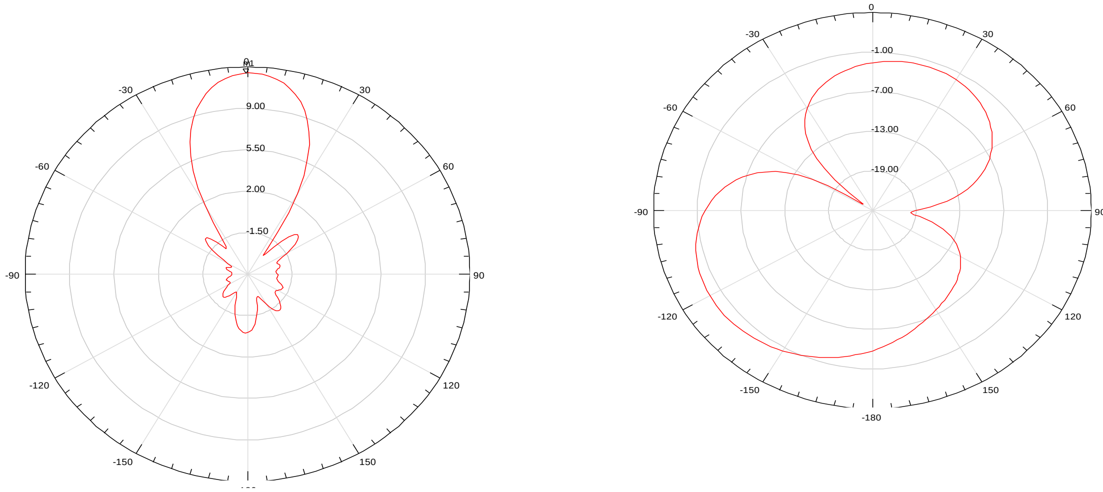

Figure 6. Gain radiation pattern

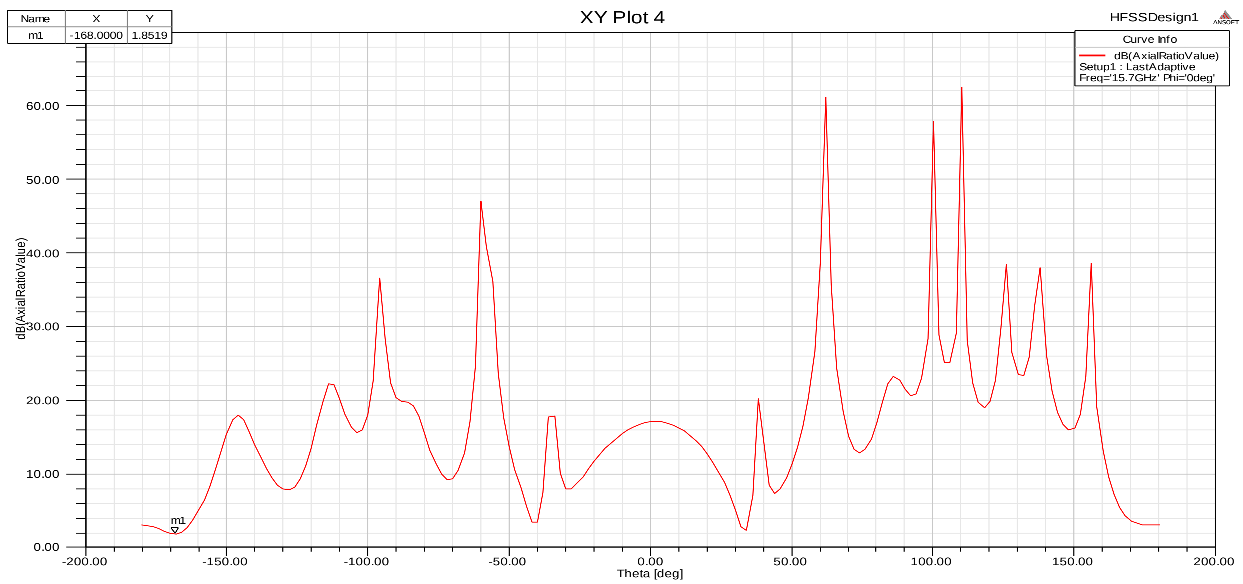

Figure 7. Axial radio

IV. CONCLUSION

A Yagi antenna design has been analyzed for Ku band in this paper. The simulation results are carried out using HFSS. It is used to perform the antenna design and then its optimization process. The antenna consists of dipole and a few coupled directors and a reflector. The reflector can improve the radiating direction and the directors can enhance the gain. The value of VSWR gain and radiation pattern has been analyzed. This antenna can be widely applied in wireless communication systems and in the field of active phased array antenna.

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