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Design of Highly Efficient Dipole Antenna using HFSS

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ABSTRACT

Diploe Antenna is the most efficient RF based Antenna which can be developed from a part of a more complicated antenna array. This paper mainly aimed in making the effective dipole antenna. The dipole antenna is one of the highest gains producing antenna and highly used in radio and telecommunication field. The efficiency level of this antenna is very high. The dipole antenna is designed using the HFSS v15 software and impedance, directivity, gain are examined. It shows that the proposed model is efficient than previous antenna.

Keywords: Dipole antenna, Radiation pattern, Efficiency, Directivity, HFSS.

1. INTRODUCTION

The dipole antenna is the most efficient class of antenna in radio and telecommunication field. The dipole antenna whose radiation pattern produced is approximately equal to a radiating structure which is having an elementary structure [1]. In dipole antenna, feed line is connected between the two conductors of equal length providing end to end connection. Dipole antennas are highly preferred to act as resonant antennas. Feed point plays a vital role in this kind of antenna. When the feed point is shorted, then the antenna is able to resonate at a particular frequency. E.g. Guitar. It is very useful for operating the antenna at particular frequency in terms of feed point impedance. Hence, the length of the feed point decides the frequency of operation. Out of these all, the use of center-fed-half-wave dipole is literally high [2]. The dipole antenna act as omni directional when it is installed vertically and act like weekly directional antenna when it is installed horizontally. Nowadays, most of the antennas used is to be seen as based on the dipole. Many directional antennas like horn, parabolic, reflector is feed by dipole antennas. It is already analyzed that vertical antennas on the base of dipole antenna design which is half of vertical antenna.

2. TYPES OF DIPOLE ANTENNA

In normal applications, shorter dipoles are used frequently and preferred where full half-wave dipole is larger in size [3]. The Hertzian dipoles are used to analyze this kind of antenna. Though these dipole antennae are shorter than a resonant antenna, the feed point impedance of dipole antenna includes a capacitive reactance which is chose to be very large in order to be practical and is used especially as a type of transmitting antenna.

2.1 DIPOLE ANTENNA OF DIFFERENT LENGTH

The resonance for a kind of a thin linear conductor will be occurring at a frequency whose wire length will be equal to half of wavelength. These kind of dipole antennas are used around that particular frequency and hence it is called as half-wave dipole antennas [4]. Dipoles with half-wavelengths in length and odd number values are used to have

low driving point impedances. Due to half-wavelength in length with even number values, the diploes are having huge driving point impedances [5,6].

2.2 HALF WAVE DIPOLE ANTENNA

In conductors which are placed end to end to get a length and with the combined two quarter-wavelength diploes are roughly equal to half wavelength which forms the half-wave dipole antenna[7]. The current whose magnitude in a standing wave along the dipole and the electric field of half-wave dipole transmitting antenna are show in the below figure Fig.1 and Fig.2.

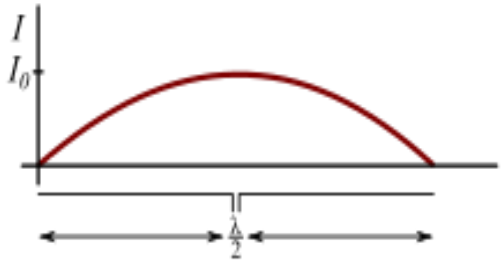

Fig 1: Standing Wave - magnitude of current waveform

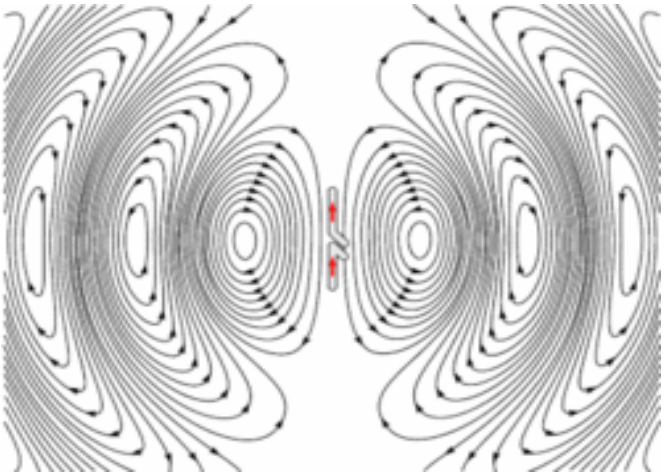

Fig 2: Half wave dipole having electric field in transmitting antenna

In general, the current (I) is distributed in the form of standing waves in which the sinusoidal is along the length of the dipole. It is having nodes at each end and antinodes at the center called feed point.

3. CHARACTERISTICS OF DIPOLE ANTENNA

3.1 IMPEDENCE OF VARIOUS LENGTH

The impedance of feed point of a dipole antenna is sensitive to both of its electrical length and feed point position. Hence, a dipole will perform over rather narrow bandwidth [8,9]. When it exceeds beyond this bandwidth the impedance will match poorly to the transmitter or receiver. The smaller dipole with small wavelength of the signal is called as short dipole. These diploes are having low level of radiation resistance which insist them to be as

ineffective antennas [10]. The Transmitter current is mostly dissipated owing to the resistance of the conductor which is greater than the Heat - radiation resistance [11].

3.2 RADIATION PATTERN AND GAIN

A dipole with the radiation falls to zero on the axis is perpendicular to the wire axis. The radiation pattern of 3D dipole is plotted approximately as a toroid symmetric about the conductor in the half wave dipole. If the antenna is mounted vertically it will result in maximum radiation in horizontal directions [12].

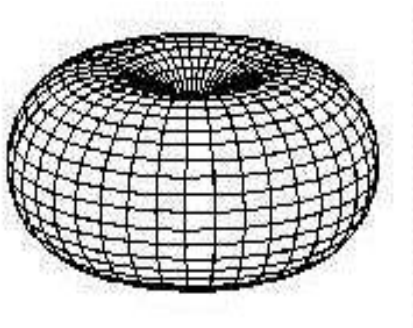

Fig 3: Directivity of Dipole Antenna

In this case when the antenna is mounted horizontally, the radiation value reaches the peak value and null value at right angles and in the direction of the dipole.

4. ANTENNA DESIGN

The design of dipole antenna is proposed in this section. Generally, a dipole antenna consists of two conductors which are half waved dipole. The designed antenna is to be surrounded with the air box which is cylindrical in shape. The height and radius of the cylindrical air box is 0.215 and 0.0775mm. The design of air box is shown in Fig.4.

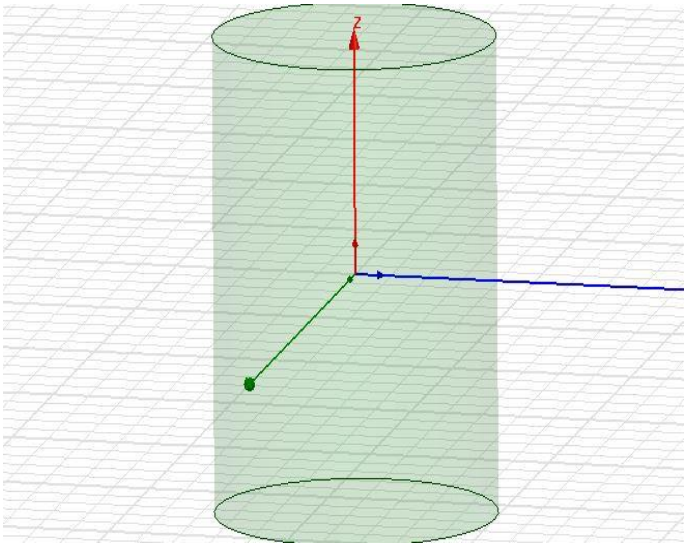

Fig 4: Air Box Surrounded Dipole Antenna

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The dipole antenna which is designed in rod shaped. The radius and height of the dipole is 0.0025mm and 0.065mm. The dipole is created using the material called pec.

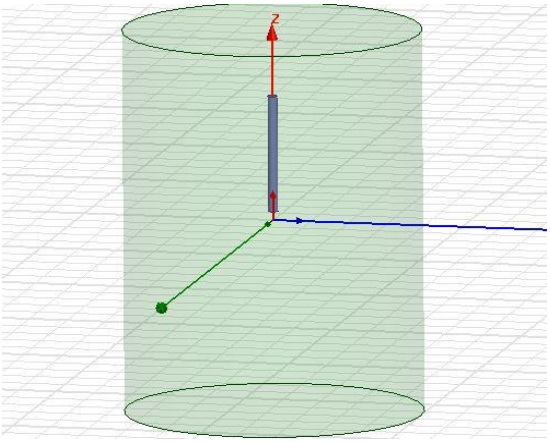

FIG 5: Air Box with Single End Dipole Antenna

The dipole antenna having two half waved dipole is to be illustrated using the below shown Fig.5 and Fig.6.

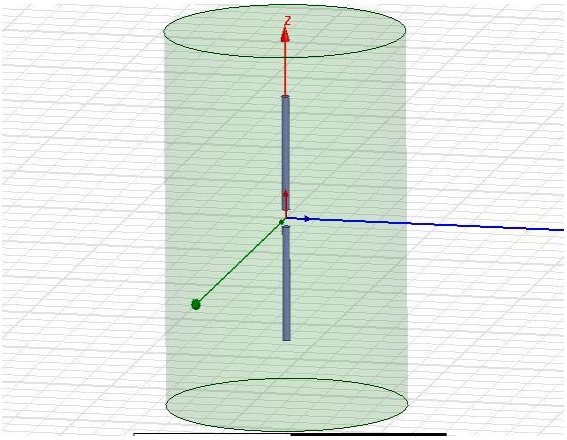

Fig 6: Air Box with Dipole Antenna

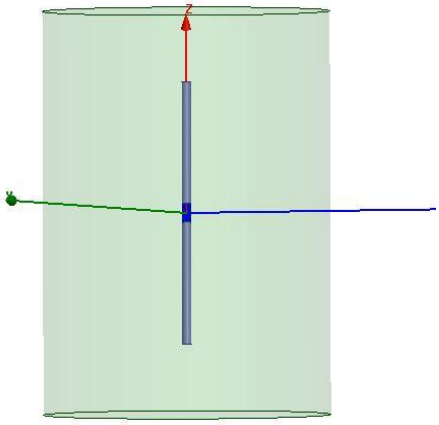

Fig 7: Dipole with Rectangular Conducting Interface

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Between the two cylindrical half wave dipole, a thin rectangular slab is to be inserted for establishing the connection between the two half wave dipoles. The rectangular sheet is to be placed in the YZ axis. The length and breadth of the rectangular sheet is 0.005mm and 0.01mm is illustrated in the below shown Fig.7.

The dipoles are of three dimensional and the rectangular sheet present between the two dipoles are of two dimendional. The horizontal and vertical view of the antennas are to be illustrated in the following figures Fig.8 and Fig.9.

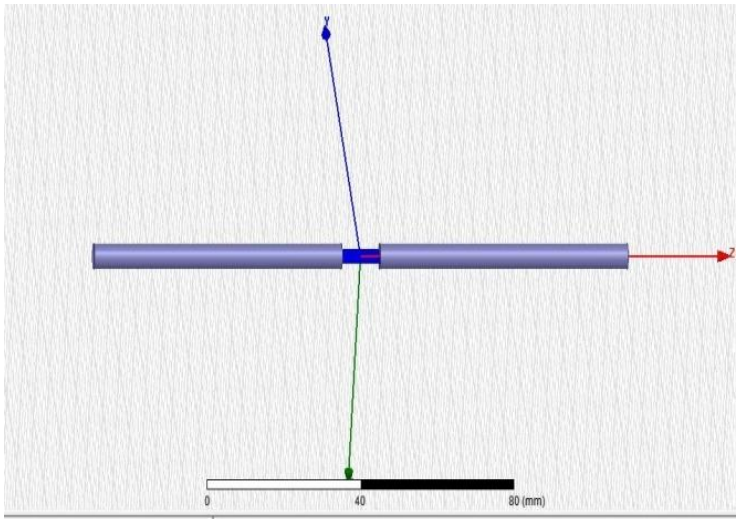

Fig 8: Horizontal View of Dipole Antenna

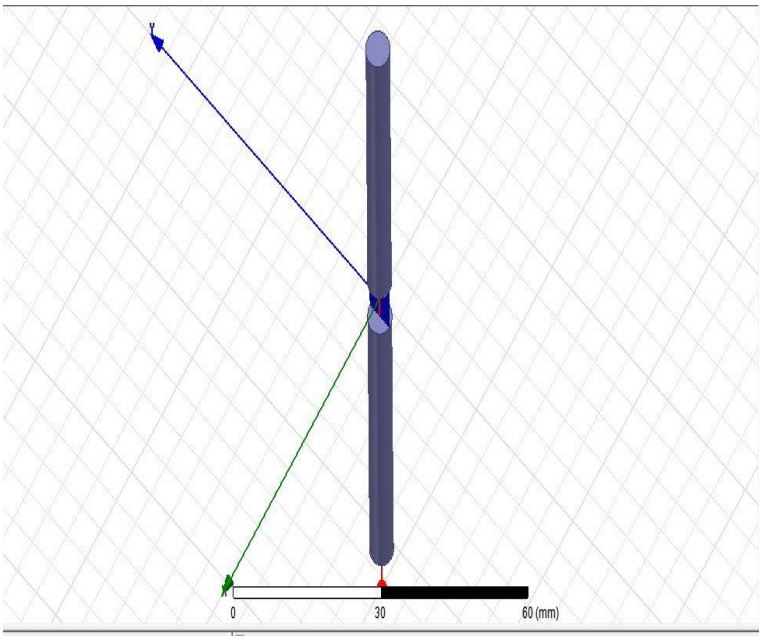

Fig 9: Vertical View of Dipole Antenna

The rectangular cylindrical sheet is to be projected accurately at the center of the two three dimensional rod shaped dipoles. The whole dipoles are to be covered with the cylindrical shaped airbox which prevents the radiation to get lossed in unwanted direction.

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5. SIMULATION RESULTS

The simulation results of dipole antenna are discussed below. The S parameters are used to identify the frequency loss which is lowered down at 1GHz. The 2D graph illustrating the S parameter values are shown in the below figure Fig.10. Its shows that the impedance of the dipole antenna is to be shown in Fig.11. The impedance and reactance are opposite to each other and the value of voltage V1 at frequency of 1 GHz is 0.0056.

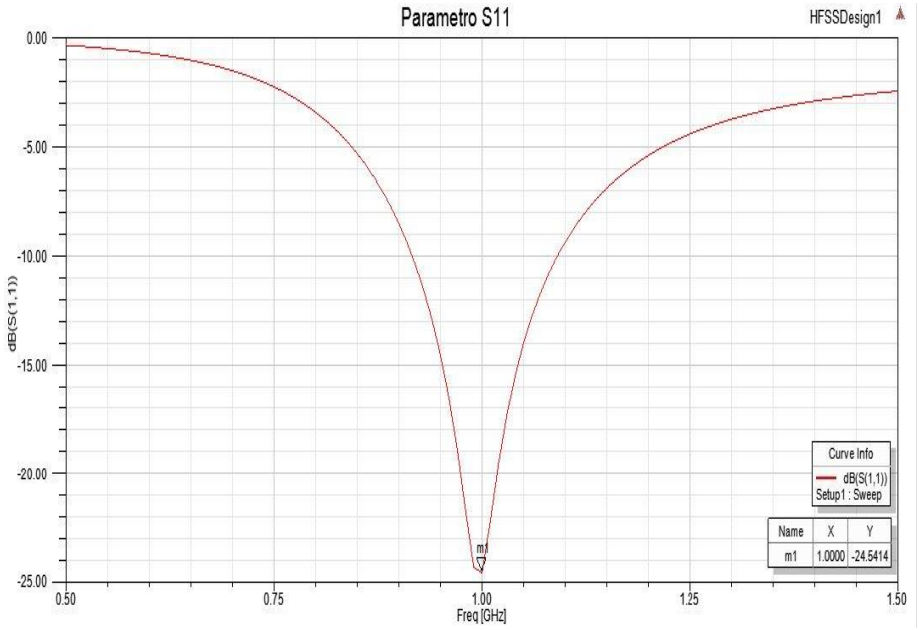

FIG 10: Frequency vs GAIN

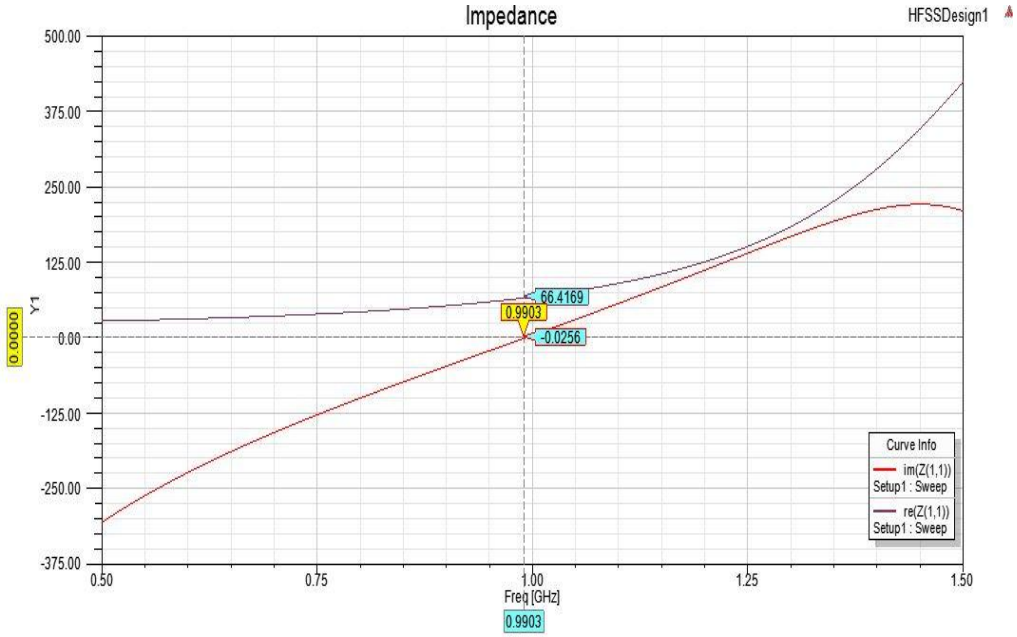

Fig 11: Impedance of Dipole Antenna

Directivity is one of the important parameters of the antenna and is defined as the measure if degree at which the radiation of the antenna tends to be projected on single direction. Generally, the directivity of the antenna is to be 1 dB. The directivity gain of dipole antenna is to be expressed in three dimensional by the below shown figure Fig.12.

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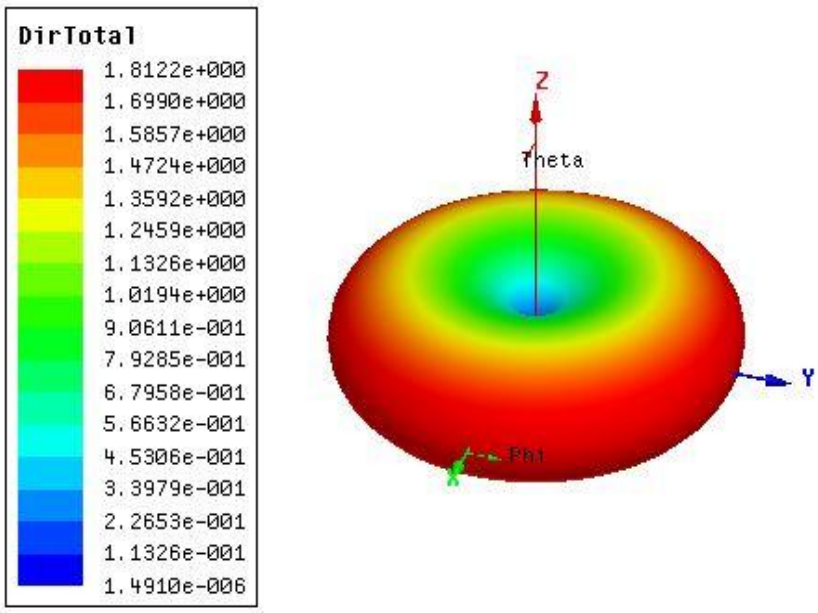

Fig 12: 3D Directivity Gain of Dipole Antenna

The total electric gain of the dipole antenna is to be shown in the Fig.13. The m1 is a point which is marked at the theta value of 270 and the angle is -90 and the magnitude value is 10.386.

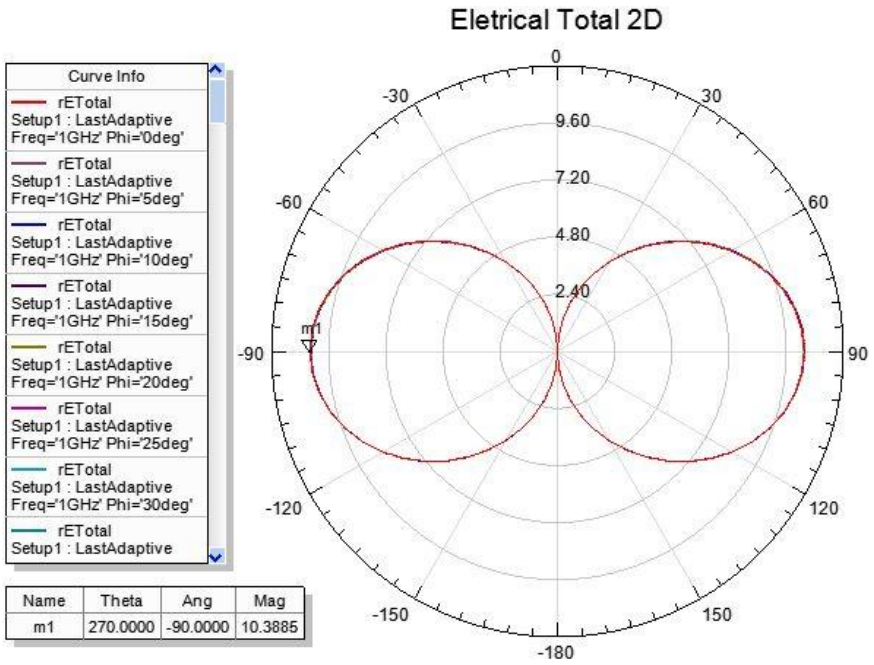

Fig 13: 2D Total Electric Gain of Dipole Antenna

The total directivity gain of the dipole antenna is to be shown in the Fig.14. The m1 is a point which is marked at the theta value of 270 and the angle is -90 and the magnitude value is 1.8047.

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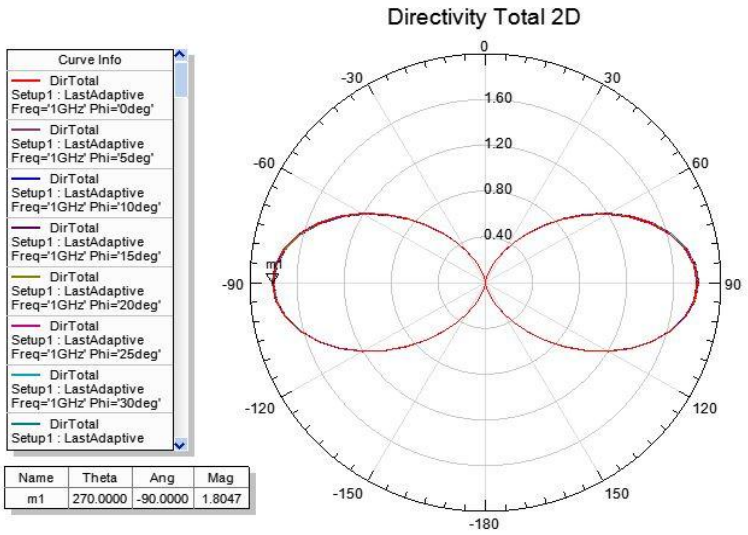

Fig 14: 2D Total Directivity of Dipole Antenna

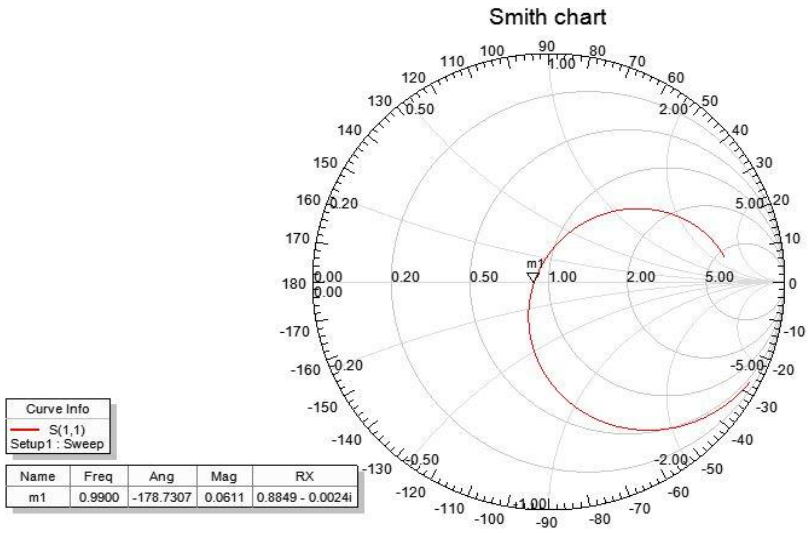

Fig 15: Smith Chart for Dipole Antenna

The smith chart is plotted at the frequency of 0.90 Hz and the angle of -178.73 and the magnitude is 0.0611. At this point the impedance value is to be calculated as 0.8849-0.002i.

6. CONCLUSION

The dipole antenna is designed using HFSS v15 software and its impedance, directivity, gain and other factors are simulated. The results show that the dipole antenna is very effective and efficient kind of antenna which can used in modular RF applications.

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