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Simulation Mobile Phone Radiation of Dipole Antenna Using HFSS

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Abstract: The use of information and communication technology is growing throughout society and world, A new products and solutions are developed at an increasing rate. Also half-wave dipole is the most common antenna in recent year, This antenna is used in all transmitters that are broadcast in all directions the parallel to the surface of the ground or in the receptors that pick up signals from all directions this work designed a new half wave dipole antenna and planar dipole antenna using the high-frequency structural simulator (HFSS software is used for the simulation and design calculations of the dipole antennas. The half wave length dipole antenna supposed as wire antenna operating at 900 MHz and 1800 MHz can be modeled in HFSS as two cylinders separated by a small gap. The proposed antenna consists of a two cylinder radiating with a rectangular lumped port excitation between each arm of dipole to provide an radio frequency excitation to antenna element. The model is then covered by a vacuum box to permit radiation of fields, radiating boundary condition will be exercised to outer surface to work as infinite free space. Further the faces of the vacuum box are individually separate and distinct selected for assigning the radiation boundary. After the simulation the measured and simulated characteristics of the antenna are shown and drawn which used a numerical and experimental results regarding the radiation characteristics are presented and discussed. The return loss, VSWR, Directivity, gain, radiation pattern are evaluated. The figure illustrated the aims of this work, Also this model shows the comparison of smith chart for input impedance and polar plot for input impedance for the proposed antennas.

Keywords: Dipole Antenna, Fdtd, High Frequency Simulator

1. Introduction

Half-wave dipole is the most common antenna. It's a two-wire with copper or aluminum being straight, where they are feeding each of the parties it's by a double cable so that the length of the wire is equal to 1/4 wavelength, where the length of the two-wire is equal to 1/2 wavelength which lead to the best reception and sending largest energy of Signal, where wavelength λ is equal to the speed of light over the center frequency the antenna is mean to operate at, the range of frequency in which half-wave dipole operates is around 3KHz to 300GHz. This antenna is used in all transmitters that are broadcast in all directions the parallel to the surface of the ground or in the receptors that pick up signals from all directions [1-3]. A novel three dimension circular conformal antenna system composed of three magneto-electric dipoles antennas has been evaluated and studied in many research. Botao Feng et al shows that the single magneto-electric dipoles element was delicately designed to include one main (lower-band) dipole and two auxiliaries (upper-band) dipoles in order to achieve the dual-band radiation [4]. The proposed magneto-electric dipoles owns a low-profile conformal geometry but features a wide H-plane beam width at degree of 103°). A Half-wave Dipole Antenna has been designed with frequency of 2.45 GHz which can operate the system. in this design, the antenna has been developed using the Copper and material such as Perfect Electrical Conductor in the CST Studio Suite 2019 Softwar [5]. The applications of half-wave dipole antenna are: used in the devices to send and receive radio and television broadcasting [6], cellular phones, and used in products such as many enterprise, homes, office modems. the overall operational electricity used to are studied and assessed, the life-cycle–based carbon footprint

(CF) relating to ICT in Sweden, including activities not commonly addressed previously, such as shared data transport networks and data centers and manufacturing of network infrastructure. Specific, detailed inventory data are presented and used for assessment of the Internet Protocol core network, data transmission, operator activities, and access network. These specific data, in combination with secondary, more generic data for end-user equipment, allow a comprehensive overall assessment [7].

The planar dipole antenna is very useful in antenna applications because of its ease of fabrication and better compactness. In recent years, planar dipole antennas have been widely used for various communication systems due to fairly good omni-directional coverage and stable radiation performance. In order to meet more real applications, there are several design challenges for dipole antennas, such as compact size, multiband operation and easy fabrication [8]. Khitam Elwasife study many work about the effect of many different frequencies radiation on human tissue the study presents a numerical analysis of specific absorption rate in the human model tissue exposed to global system mobile phone radiation. The results showed electric, magnetic fields and specific absorption rate in 1D FDTD method. Also the electric field in tissue has been evaluated in 2D FDTD method. To develop the model, MATLAB tool were used and result from the model was analysis and also compare result theoretically with the other researcher [9-11]. The effect of the user hand grip on the design of 5G millimeter-wave (mmWave) mobile handsets has been studied [12], also the high-frequency structure simulator (HFSS) is wasted the characterize of electromagnetic fields for antenna variable placements. According that assumption, the loss from hand blockage on the antenna gains can be up to 20-25 dB, which implies that the possible hand grip profiles need to be taken into account while designing the antenna module placement and beamforming codebook. The results illustrated that the 5G mmWave handsets are different from pre-5G handsets, the user grip needs to be analyzed into the antenna position and the codebook styling [12]. Another work evaluated that When a dipole antenna above the metal reflector with half a wavelength was installed, by using simulated method the results in research was indicated that the proposed structure achieved good isolation [13]. Different frequency of global mobile radiation are used in their study The antenna performance factors such as radiation pattern, gain, VSWR, and return loss were analyzed in this research. Half wave dipole antennas were created and analyzed using HFSS simulation software at 900 MHz and 1800 MHz, proving that the suggested model is an effective dipole antenna type in the targeted frequency range. With the proposed antenna designs and measurable performance characteristics investigated. M. H. Teimouri et al [14], discussed a novel printed dipole with an integrated balun and tuning element for DTV application, their results indicate and confirm that the proposed antenna covers an impedance bandwidth of 414.5 MHz from 457.7 to 872.2 MHz, which covers the frequency band of DTV systems (470–862 MHz). furthermore the model of half wave dipole antenna designed with copper material at 1800 MHz frequency has been studied where it examine the performance parameters, through out the simulation results which observed by simulation if dipole antennae with frequency 1.8GH by using soft programs, their study aimed to evaluate the specific absorption rate(SAR) in human body. It is useful to use this type of dipole [15]. In this study, the researcher designed a new half wave dipole antenna and planar dipole antenna using the HFSS (high-frequency structural simulator) software is used for the simulation and design calculations of the dipole antennas. The return loss, VSWR, Directivity, gain, radiation pattern are evaluated.

2. Design and Model of Dipole Antenna

The half wave length dipole antenna (wire antenna) operating at 0.9 GHz and 1.8GHz can be modeled in HFSS as two cylinders separated by a small gap as shown in Figure (1).

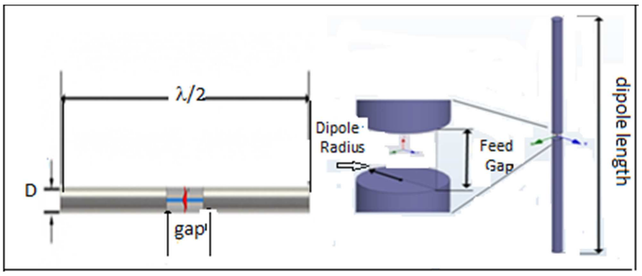

Figure 1. *Thehalf Wave Dipole Antenna (Wire Antenna).*

Dimensions of an antennas changes based on the resonant frequency. As a resonant frequency 0.9GHz and 1.8GHz has been chosen. The parameters used in the final model are shown in Table 1, and Table 2.

Table 1. *Design Parameters of the Half Wave Dipole Antenna Operating in 0.9GHz.*

parameter	Value uint
Resonant frequency (f)	0.9 GHz
Length of dipole (L)	149.99 mm
Port Impedance (Z_0)	50 Ω
Feed Gap (G)	2.5 mm
Radius of dipole (R)	2.5 mm

Table 2. *Design Parameters of The half Wave Dipole Antenna Operating in 1.8GHz.*

parameter	Value unit
Resonant frequency (f)	1.8 GHz
Length of dipole (L)	74.99 mm
Port Impedance (Z_0)	50 Ω
Feed Gap (G)	1.25 mm
Radius of dipole (R)	1.25 mm

Table 3. *Design Parameters of the Planar dipole Antenna Operating in 0.9GHz.*

parameter	Value unit
Resonant frequency (f)	0.9 GHz
Length of dipole (L)	141.17 mm
Width of dipole	3.53 mm
Port Impedance (Z0)	50 Ω
Feed Gap Length (G)	3.53 mm
Substrate thickness	62 mil

parameter	Value unit
Substrate Dimension Along x	211.8 mm
Substrate Dimension Along y	282.3 mm

Table 4. *Design Parameters of the Planar Dipole Antenna Operating in 1.8GHz.*

parameter	Value unit
Resonant frequency (f)	1.8 GHz
Length of dipole (L)	68.18 mm
Width of dipole	1.7 mm
Port Impedance (Z_0)	50 Ω
Substrate thickness	62 mil
Substrate Dimension Along x	102.3 mm
Substrate Dimension Along y	136.4 mm

The planar dipole antenna operating at 0.9 GHz and 1.8GHz can be modeled in HFSS as shown in Figure 2.

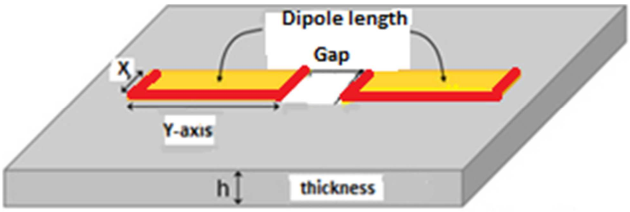

Figure 2. *Theplanar Dipole Antenna.*

Dimension of an antenna changes based on the resonant frequency. As a resonant frequency 0.9GHz and 1.8GHz has been chosen. The parameters used in the final model are shown in Table 3, and Table 4.

3. Results and Discussion

The half dipole antenna (wire antenna) and planar dipole antenna is simulated in high frequency structure simulator (HFSS). The simulation model is given in Figure 3 and Figure 4. As shown in the Figure 3a and Figure 4a the proposed antenna design which consists of a two cylinder radiating with a rectangular lumped port excitation between each arm of dipole to provide an RF excitation to antenna element. The structure is then covered by a vacuum box to allow radiation of fields, radiating boundary condition will be applied to outer surface to act as infinite free space. Further the faces of the vacuum box are individually selected for assigning the radiation boundary. After the simulation the measured and simulated characteristics of the antenna are shown and drawn which used a numerical and experimental results regarding the radiation characteristics are presented and discussed. Figures 5 and 6 shows comparison between return loss curves for half dipole antenna (wire antenna) and planar dipole antenna at 900MHz and 1800MHz. From this analysis we can the operating frequency and return loss values for planar dipole antenna at 900MHz in Figure 5b is lower than half dipole antenna at 900MHz in Figure 5a. in Figure 5 we use many parameter as Relate Return Loss S11[dB] for Frequency at 900 MHz for which obvious in curve (5a) that is a Half wave Dipole Antenna, Return Loss: -17.28dB at 0.88 GHz Frequency, and in curve (5b) the Planar Dipole Antenna, Return Loss: -20.89dB at 0.89 GHz Frequency. Also the operating frequency and return loss values for planar dipole antenna at 1800MHz in Figure 6b is lower than half dipole antenna at 1800MHz in Figure 6a. In the result window of return loss, one can see single deep curve which shows proposed designed half wave dipole antenna being single band antenna, whereas if it could show two heavy curve then its paired band antenna.

The measured Voltage Standing Wave Ratio (VSWR) of the simulated antenna is given in the Figures 7 and 8 which illustrated Voltage Standing Wave Ratio for both frequency at 900 MHz and 1800 MHz, for Figure 7a the half wave dipole antenna VSWP: 2.38 at 0.88 GHz Frequency, and in Figure 7b the planar dipole antenna, VSWP: 1.57 at 0.89 GHz Frequency. The Figures 9-12 shows the comparison of smith chart for input impedance and polar plot for input impedance for the proposed antennas.

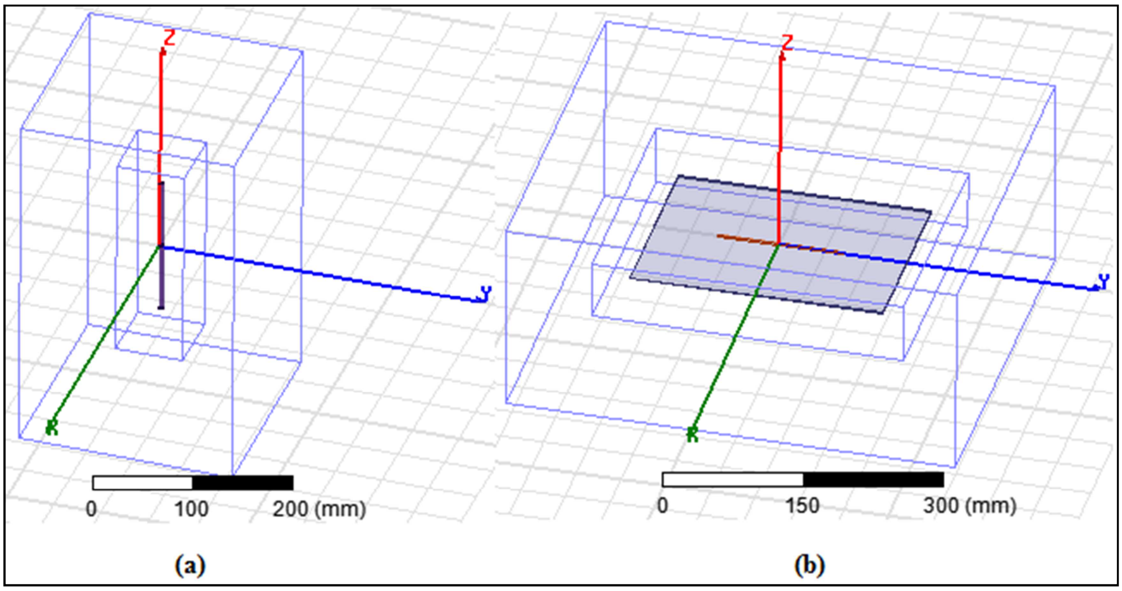

Figure 3. *Designed Antenna at 900 MHz for: (a) the half Wave Dipole Antenna (Wire Antenna), (b) the Planar Dipole Antenna.*

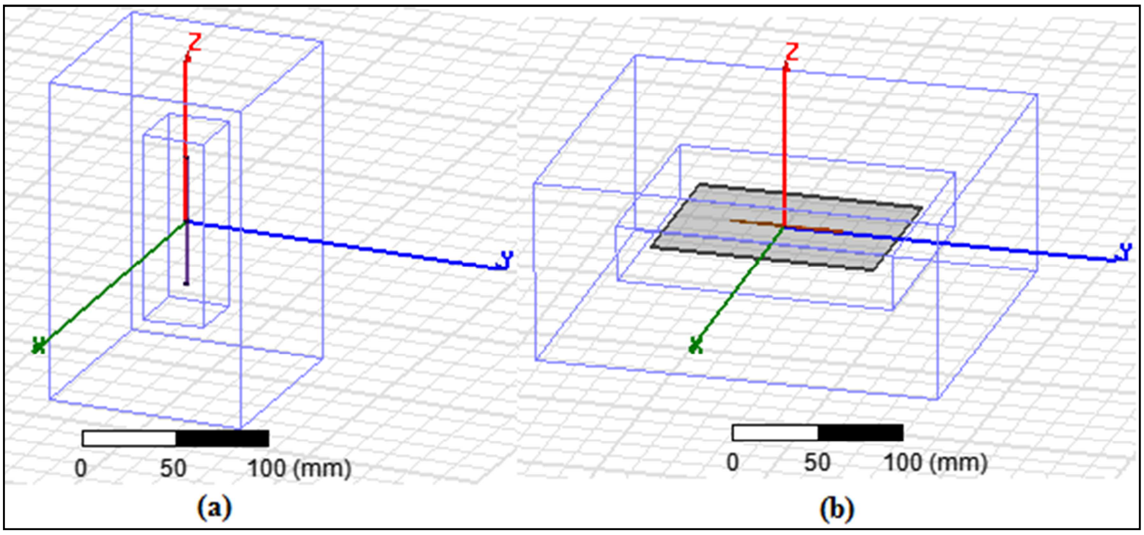

Figure 4. *Designed Antenna at 1800 MHz for: (a) the half Wave Dipole Antenna (Wire Antenna), (b) the Planar Dipole Antenna.*

The plot of return loss for above antenna is shown below:

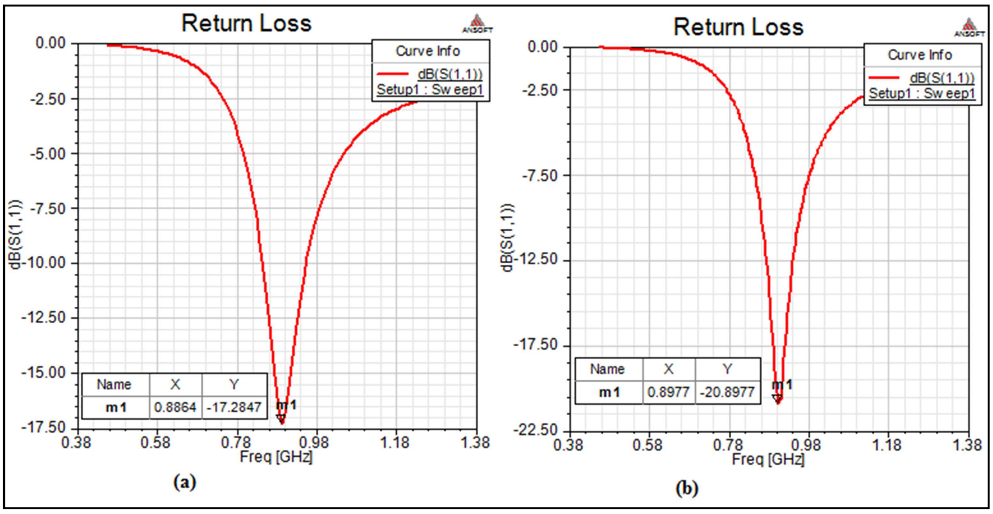

Figure 5. *Relate Return Loss S11[dB] for Frequency at 900 MHz for: (a) the Half wave Dipole Antenna (Wire Antenna), Return Loss: -17.28dB at 0.88 GHz Frequency, (b) the Planar Dipole Antenna, Return Loss: -20.89dB at 0.89 GHz Frequency.*

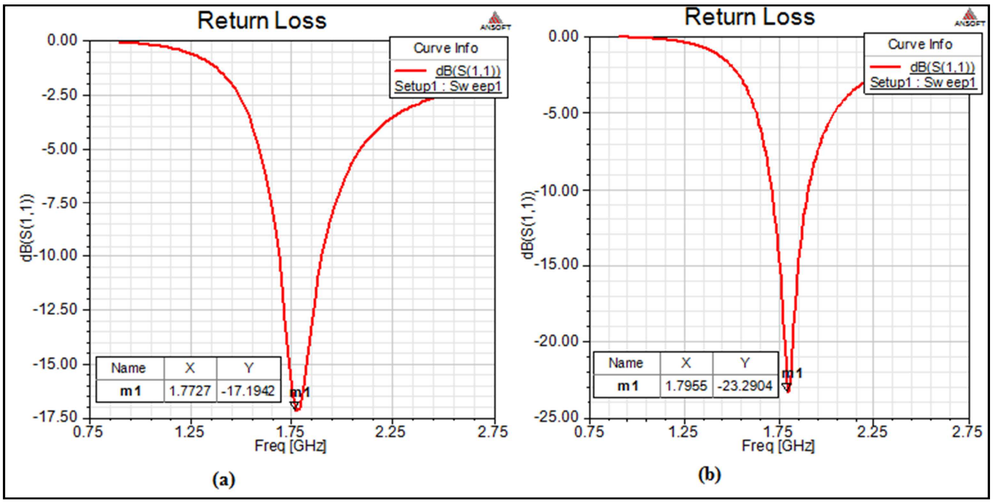

Figure 6. *Relate Return Loss S11 [dB] for frequency at 1800 MHz for: (a) the half wave dipole antenna (wire antenna), Return Loss: -17.19dB at 1.77 GHz Frequency, (b) the planar dipole antenna, Return Loss: -23.29dB at 1.79 GHz Frequency.*

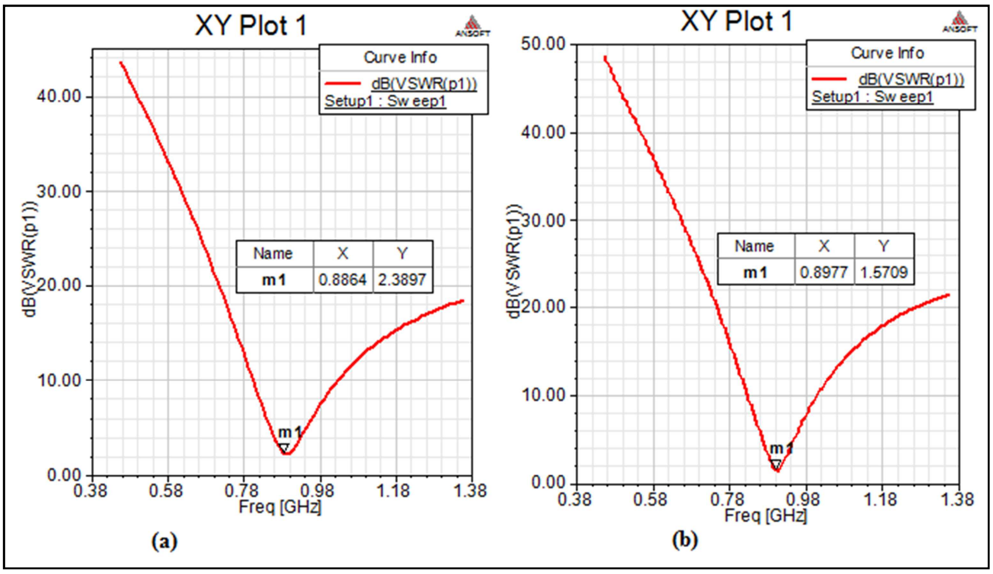

Figure7. *VSWP (Voltage Standing Wave Ratio) for frequency at 900 MHz for: (a) the half wave dipole antenna (wire antenna), VSWP: 2.38 at 0.88 GHz Frequency, (b) the planar dipole antenna, VSWP: 1.57 at 0.89 GHz Frequency.*

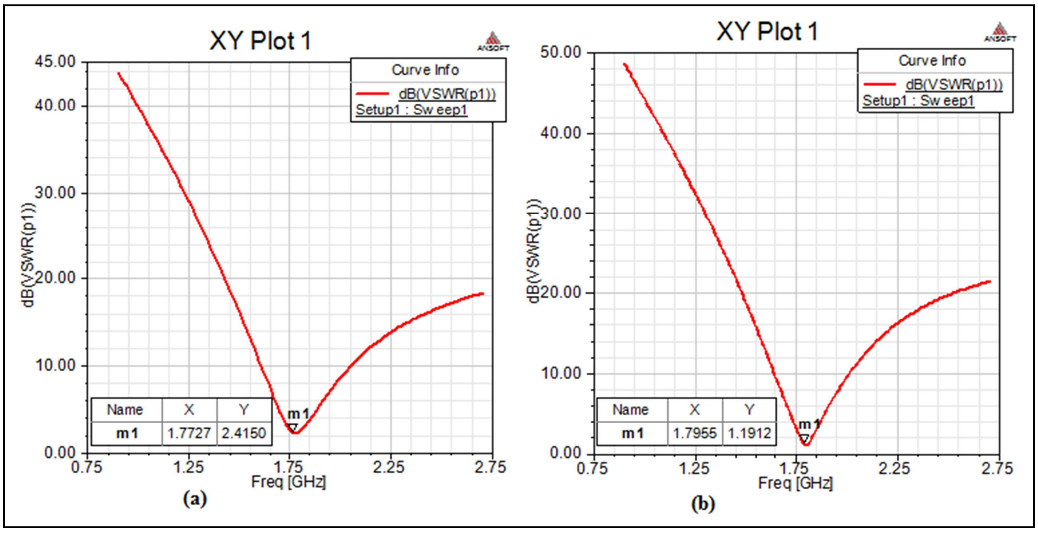

Figure 8. *VSWP (Voltage Standing Wave Ratio) for Frequency at 1800 MHz for: (a) the Half Wave Dipole Antenna (Wire Antenna), VSWP: 2.41 at 1.77 GHz Frequency, (b) the Planar Dipole Antenna, VSWP: 1.19 at 1.79 GHz Frequency.*

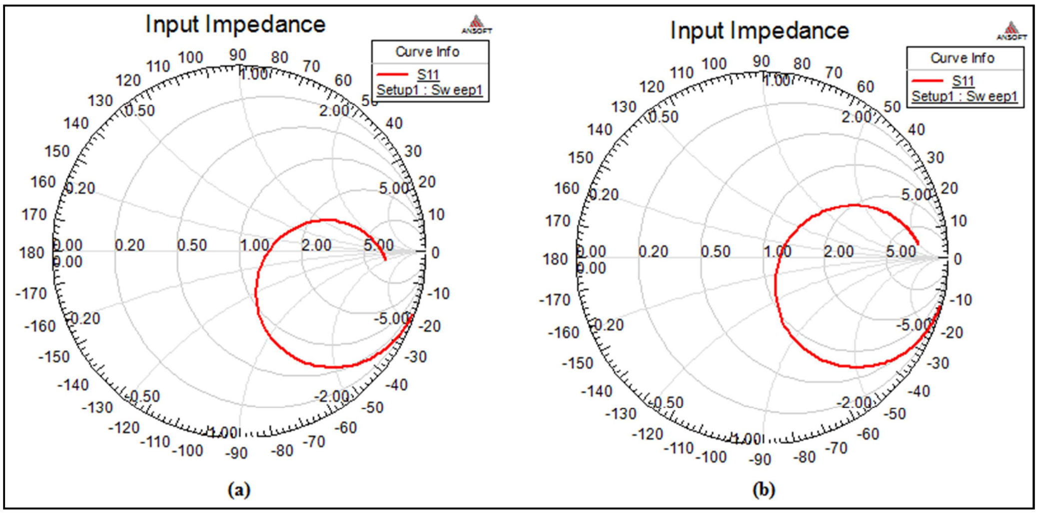

Figure 9. *Smith Chart for Input Impedance for Frequency at 900 MHz for: (a) the Half wave Dipole Antenna (Wire Antenna), (b) the Planar Dipole Antenna.*

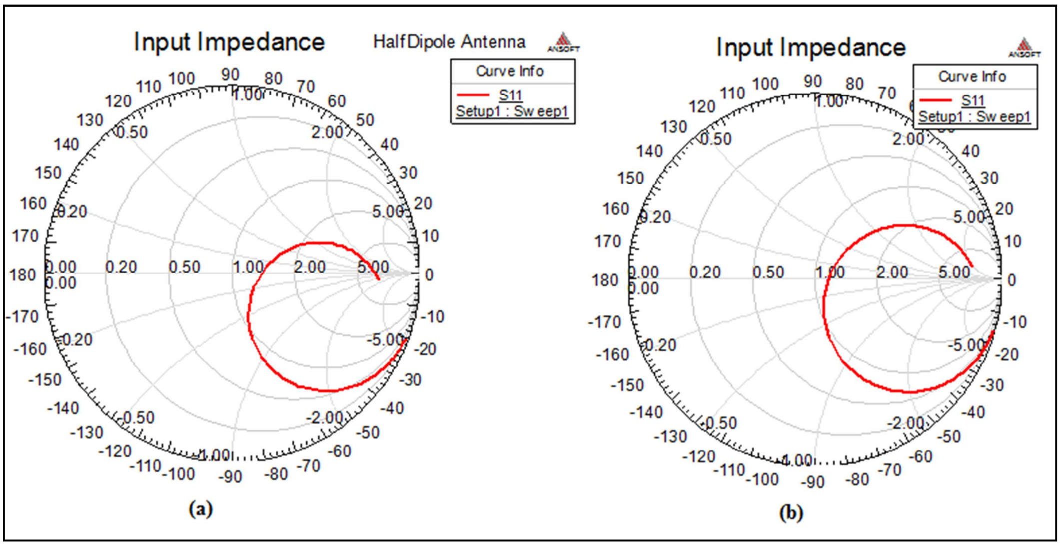

Figure 10. *Smith Chart for Input Impedance for Frequency at 1800 MHz for: (a) the half Wave Dipole Antenna (Wire Antenna), (b) the Planar Dipole Antenna.*

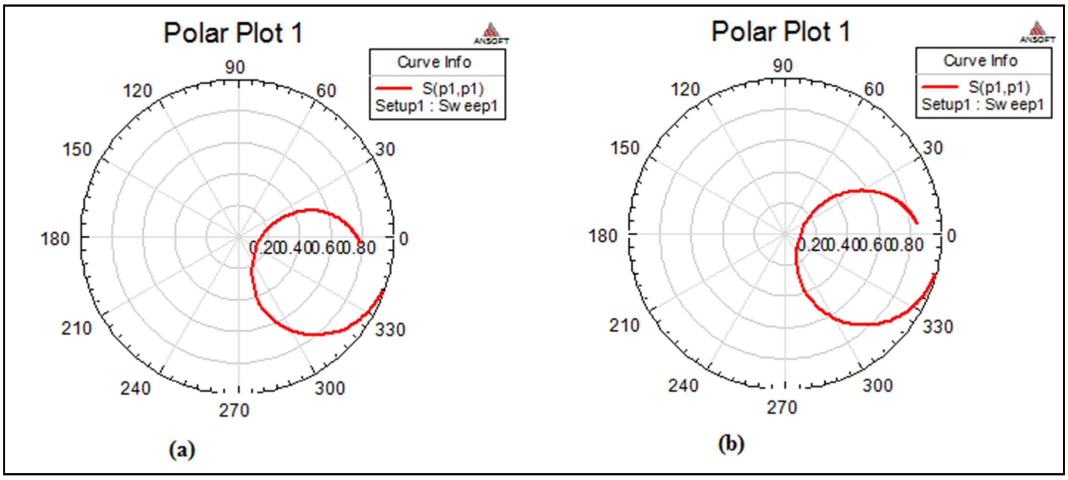

Figure 11. *Polar Plot for Input Impedance for Frequency at 900 MHz for: (a) the half Wave Dipole Antenna (Wire Antenna), (b) the Planar Dipole Antenna.*

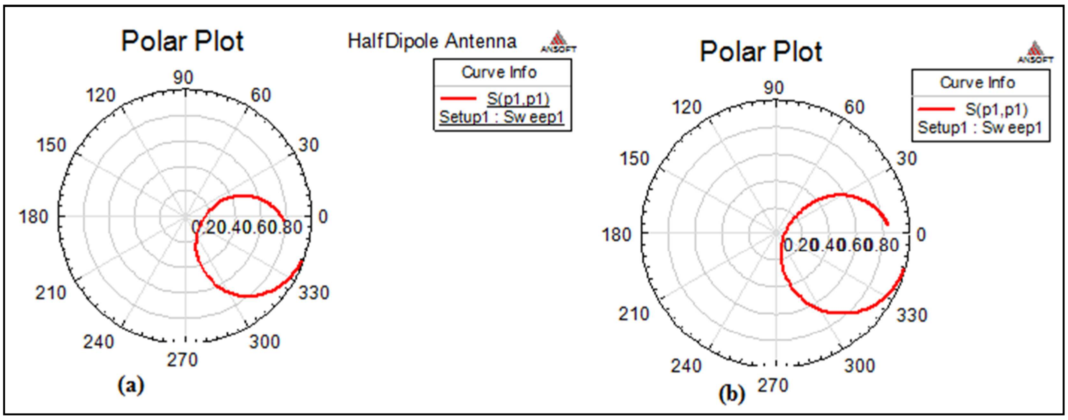

Figure 12. *Polar Plot for Input Impedance for Frequency at 1800 MHz for: (a) the half wave Dipole Antenna (Wire Antenna), (b) the Planar Dipole Antenna.*

4. Conclusion

The dipole antenna is used in a variety of radio frequency antenna designs to fully the desired performance evaluated that the assumption model is very good type of antenna which effective dipole antenna type in the targeted frequency range. With the proposed antenna designs and measurable performance characteristics investigated, the new research scholars can readily execute their new antenna inventions.

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