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Reshaped Monopole Antenna structure fit for short range wireless access

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ABSTRACT

Monopole antenna acts as an open resonator for radio waves, hence often named as resonant antenna. The operating wavelength defines the length of the antenna. The design approach of reshaped monopole antenna is simple. By employing the design procedures of monopole antenna, modifications are done in the monopole structure in order to enable it resonate at the design frequency of 5.846 GHz. This frequency lies within ISM (Industrial, Scientific and Medical) band and hence it is useful for short range wireless applications. The design of reshaped monopole antenna is implemented using Agilent ADS 2009 and various parameters such as directivity, gain, return loss, radiation pattern are obtained for the designed frequency.

Keywords
Reshaped Monopole structure; Operating frequency band; Antenna Parameters; Return loss; Radiation Pattern

Characteristics of Monopole Antenna

For effective operation, only half of the dipole antenna is needed as shown in Figure 1. Half structure of the dipole antenna is named as monopole antenna. It indicates one of the physical sides. Appropriate excitation is applied to the monopole antenna with respect to ground plane.

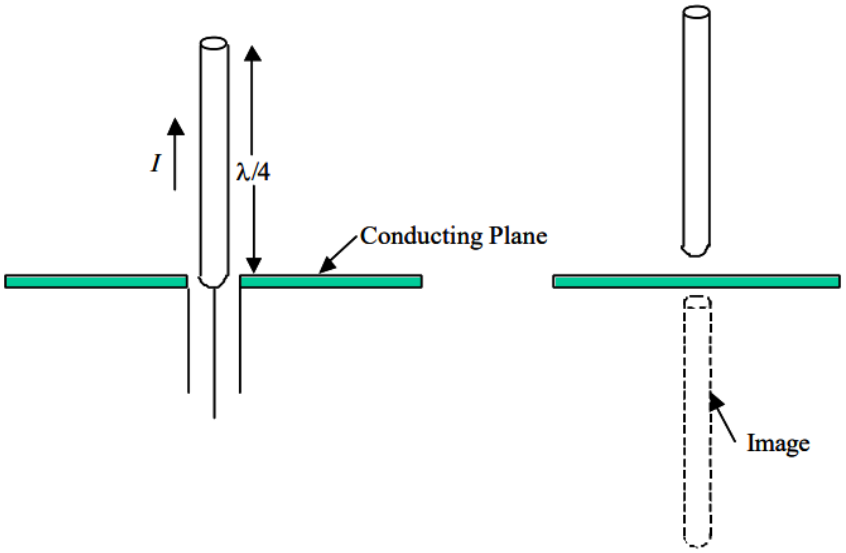

Figure 1. Basic Monopole Antenna structure

- Input impedance of monopole antenna:

$$Z_{monopole} = \frac{1}{2} Z_{dipole} = 36.5\ \Omega$$

- Length of monopole Antenna = λ/4

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- Radiation is present on top half of the monopole structure while zero field below the ground plane.

- Directivity:

$$D_{monopole} = 2D_{dipole}$$

- Electric field intensity:

$$E = \frac{j\eta I_o \cos(\frac{\pi}{2}cos\theta)}{2\pi r sin\theta} e^{-j\beta r} a_\theta \text{ V/m}$$

- Magnetic field intensity:

$$H = \frac{j I_o \cos(\frac{\pi}{2}cos\theta)}{2\pi r sin\theta} e^{-j\beta r} a_\phi \text{ A/m}$$

- Total Power radiated:

$$P = \frac{1}{2} I_0^2 R_{rad} \text{ W}$$

- Radiation Resistance $R_{rad} \approx 36.5\ \Omega$

Literature Review

The maximum directivity is obtained in the upper radio horizon of assumed quarter-wave monopole antenna with better directivity of 5.31dB. The obtained radiation pattern makes monopole as a better choice for modern day communication systems [1].Larger Bandwidth is obtained for the designed monopole antenna operating at ISM band frequencies of 2.4 GHz and 5.2/5.8 GHz [2]. The antenna being designed finds its applications in spatial diversity systems and small portable devices.

Planar circular monopole antenna [3] suited for UWB band has been designed. The omnidirectional radiation pattern is obtained with peak gain of 2.8dB for entire frequency band. It further supports various bands such as C, X, Ku, K, Ka band, WLAN, and future wireless services.Dual band operation of microstrip fed printed monopole antenna [4] is designed at 2.43GHz and 5.24GHz. 9-shapedd printed monopole is designed for WLAN and RFID applications.Printed rectangular monopole antennas [5] resembling patch antenna has been designed to operate at multiband frequencies. They are less fragile and planar structures.

Monopole antenna find its applications in

- Cellular and cordless telephones,
- Walkie-talkies,
- Citizen Band radios, etc.

Benefits of operating frequency band- 5.8 GHz band (5725 to 5875 MHz)

- Higher Bandwidth,
- Less interference,
- Unlicensed,
- Operates in ISM (Industrial Scientific Medical) band.

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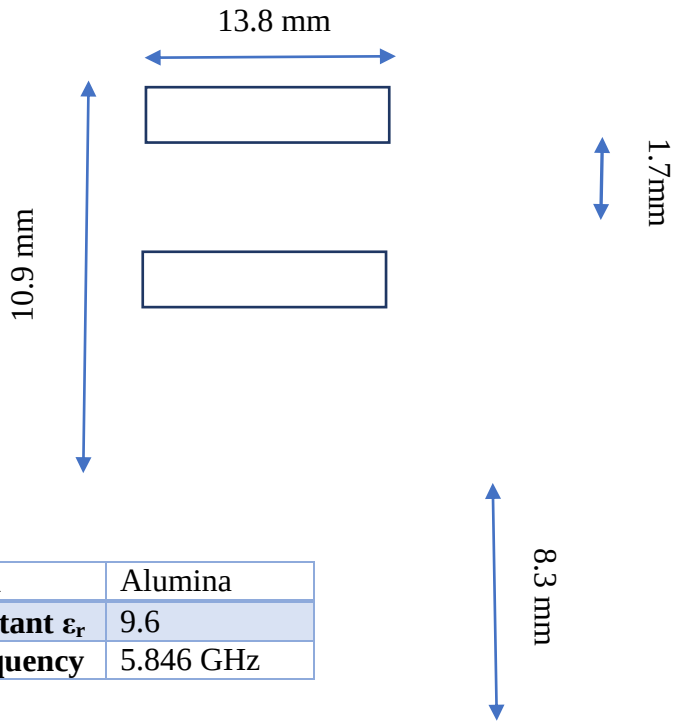
Design Specifications of the Reshaped Monopole Antenna



Substrate used	Alumina
Dielectric constant ε_r	9.6
Operating frequency	5.846 GHz

Figure 2. Reshaped Monopole Antenna structure operating at 5.846 GHz

Simulated Results for the designed antenna

Due to mismatch between the impedance of the line and the load or antenna, a part of signal reflects back to source. Thus, return loss relates incident signal to the reflected signal. The return loss of
-29.675dB is realized at 5.846GHz.

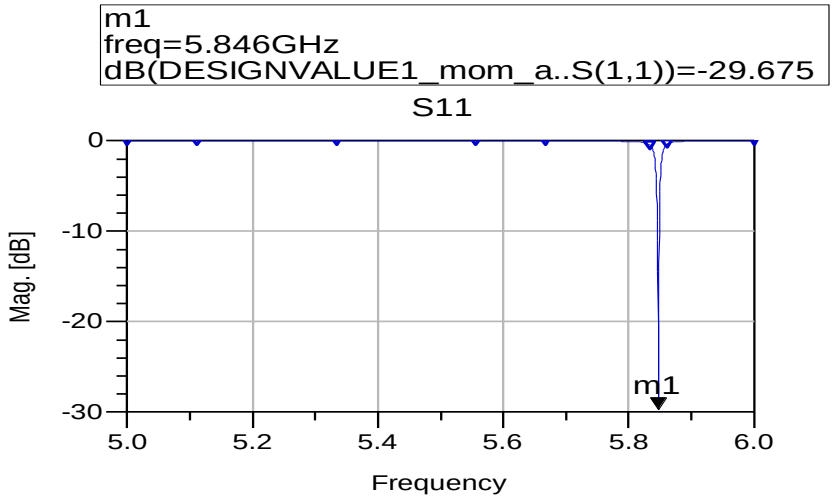


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Figure 3. Return loss of the Reshaped Monopole Antenna structure operating at 5.846 GHz

Antenna gain is made of two components such as directivity and efficiency.

$$G = k\,D$$

Where k – efficiency

D – Directivity

The directivity and gain observed for the designed antenna is 5.56172dB and 5.56502dB. Theradiated power from designed antenna is 0.0000420197 Watts.

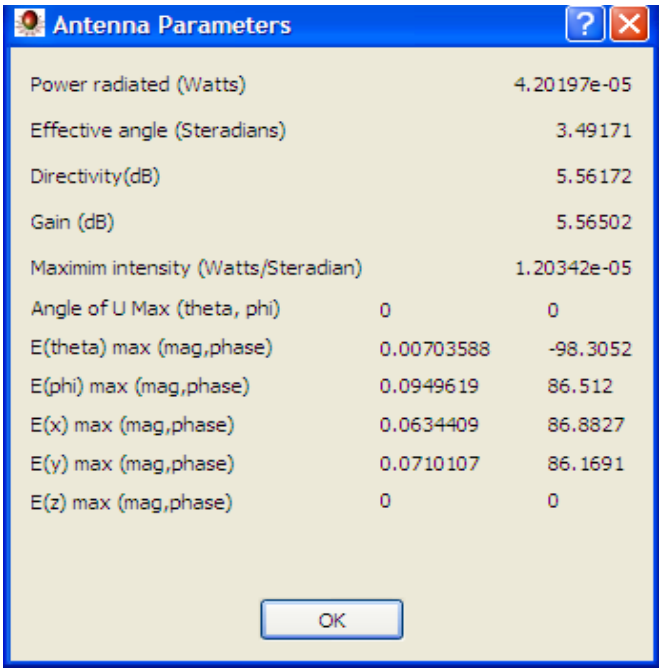

Figure 4. Antenna Parameters being simulated using Agilent ADS tool

Angular dependence of field strength of radio waves from the designed antenna is given by simulated radiation pattern. Omnidirectional pattern is achieved for the desired band.

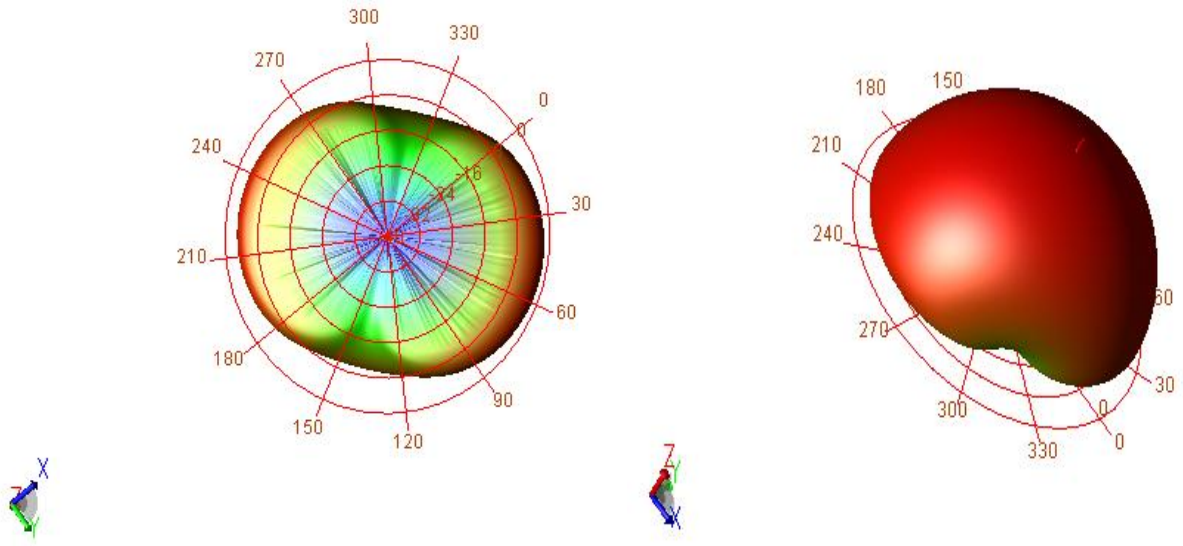

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Figure 5. Radiation Pattern for the designed monopole at 5.846 GHz band

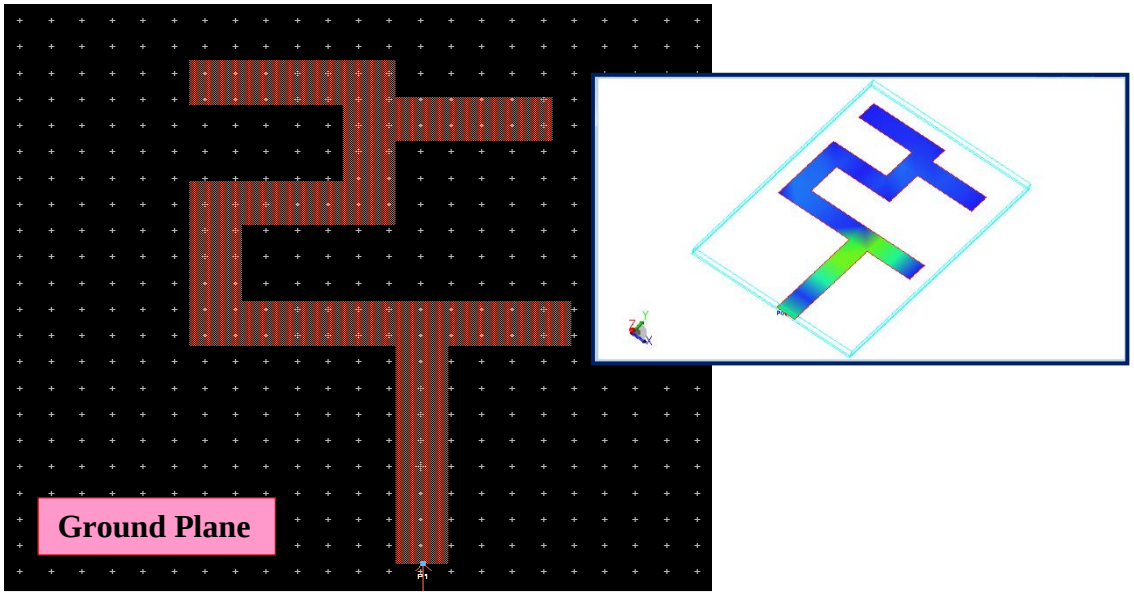

Figure 6. Simulated Far field analysis of the designed reshaped monopole at 5.846 GHz

Conclusion and Future work

The simulation work deals with the design of reshaped monopole antenna for short range wireless access. The designed monopole antenna resonates at 5.846 GHz. The return loss graph shows optimum value of -29.675dB at 5.846GHz.The directivity of the designed antenna is 5.56172dB and gain of about 5.56502dB is obtained. The directivity and gain result obtained implies that the designed antenna exhibits optimum performance at the required resonant frequency. The designed antenna is compact and occupies less space and is more suitable for modern day wireless applications. The future work could be extended such that the designed antenna is modified to resonate at multiple frequencies. The size of antenna could be further be reduced.

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