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Half-Wave Dipole Antenna for GSM Applications

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Abstract

The dipole antenna or dipole aerial is one of the most important and commonly used types of RF antenna. It is widely used on its own, and it is also incorporated into many other RF antenna designs where it forms the driven element for the antenna. In this paper, an attempt has been made to investigate new half wave dipole antenna for GSM Applications. A dipole antenna approximately one-half wavelength long is the half wave dipole antenna. The antenna is made to resonate at the 1.995 GHz frequency. CST MWS Software is used for the simulation and design calculations of the half wave dipole antennas. The return loss, VSWR, Directivity, gain, radiation pattern are evaluated. Using CST MWS simulation software proposed antenna is designed/simulated and optimized. The antenna exhibits a frequency band from 1.877 GHz to 2.1199 GHz which is suitable for applications.

Keywords

Half Wave Dipole Antenna, GSM, CST Microwave Studio, Single Band.

1. Introduction

A half wave dipole wire antenna is introduced which is operating at 1.995 GHz frequency and will be used for GSM application, which is one of the most important and widely used standard for mobile communications. Dipole antenna is a radio antenna that can be made of a simple wire, with a center-fed driven element. It consists of two metal conductors of rod or wire, in line with each other, with a small space between them. The radio frequency voltage is applied to the antenna at the center, between the two conductors. The geometry of this antenna, which is a cylindrical structure, is fully described by five parameters, including length, radius, feeding gap, frequency and wavelength.

For a half wave dipole the length of the dipole should be half of the wavelength but practically it's 0.45 times of the wavelength. The dipole antenna consists of two terminals or "poles" into which radio frequency current flows. This current and the associated voltage causes and electromagnetic or radio signal to be radiated. Being more specific, a dipole is generally taken to be an antenna that consists of a resonant length of conductor cut to enable it to be connected to the feeder. Typically a dipole antenna is formed by two quarter wavelength conductors or elements placed back to back for a total length of λ/2. A standing wave on an element of a length λ/4 yields the greatest voltage differential, as one end of the element is at a node while the other is at an antinode of the wave. The larger the differential voltage, the greater the current between the elements.-as in [1].

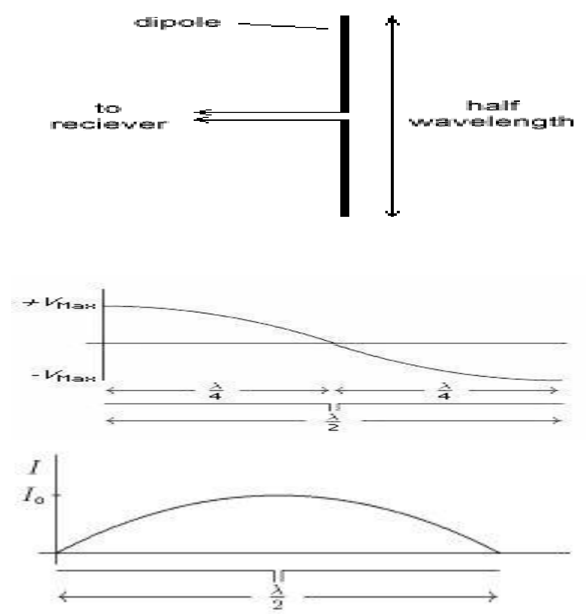

Fig.1. (a): Geometry of half wave dipole antenna (b) Voltage distribution (c) Current distribution-as in [3]

2. Geometry of Half Wave Dipole

In this antenna the half wave dipole has the length L=70.44 mm which is 0.45 times of the wavelength and the radius R=0.14778mm. The feeding gap g=0.3522mm. In this work the feeding impedance of 73 ohms is being used. Antenna is designed for the resonating frequency of 1.995 GHz.

To design the half wave dipole antenna the following relationships are being used to calculate the dimensions of the half wave dipole antenna.-as in[3]

$W_v = c/f$ (1)

$L = 0.475\ W_v = 143/f\ (MHz)$ (2)

$R = D/2 = 0.001 Wv$ (3)

$g = L/200$ (4)

Where,

L=length of antenna
R=radius of antenna
f=resonating frequency
g=feeding gap
W_v=wavelength

Free Space Far-field Radiations: For the half –wave dipole the far-field radiations are calculated by using the formula-as in [2]

$F_n(\theta) = [\cos((\pi/2)(\cos\theta)/\sin(\theta)]^2$ (5)

Gain of Dipole Antenna: Following is the formula for calculating the gain of half wave dipole-as in [4]

$G_{\lambda/2} = 60^2/30R_{\lambda/2}$ (6)

Input Impedance: The input impedance is calculated for half wave dipole which is given as following -as in [12]

R=73 (ohms) (7)

3. Design Parameters

Fig (2) shows the front view geometry and the structure designed on CST Microwave Studio software of the half wave dipole antenna for GSM application. The dimensions and parameters for proposed antenna have been optimized so as to get the best possible impedance match to the antenna. The following parameters are used for design of proposed antenna.

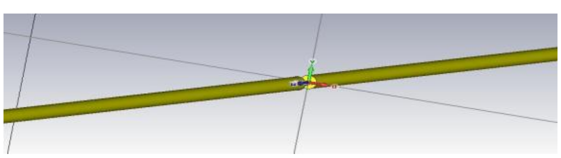

Fig. 2: Design Structure on CST Microwave Studio

Design frequency = 0 - 3 GHz
Length of wire = 70.44 mm
Radius of wire= 0.14778 mm
Feed gap = 0.3522 mm

4. Simulation Results

A prototype of the proposed half wave dipole antenna of length 70.44 mm, radius 0.14778 mm and feed gap 0.3522 mm was designed and constructed to resonate at 1.995 GHz frequency. The achieved antenna impedance is 73 ohm as shown in Fig.6, which is the required impedance.

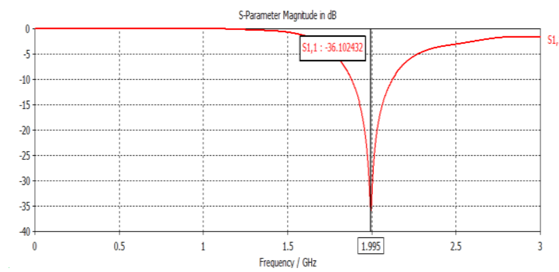

Fig. 3: Simulated Return loss curve

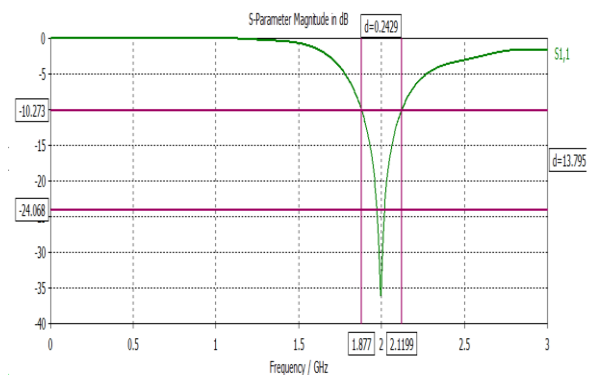

Fig.4: Bandwidth plot for GSM

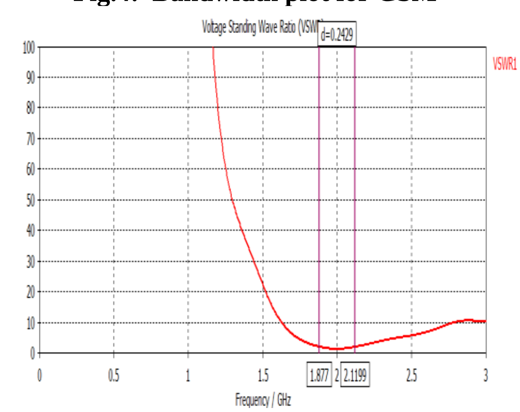

Fig.5: VSWR Curve

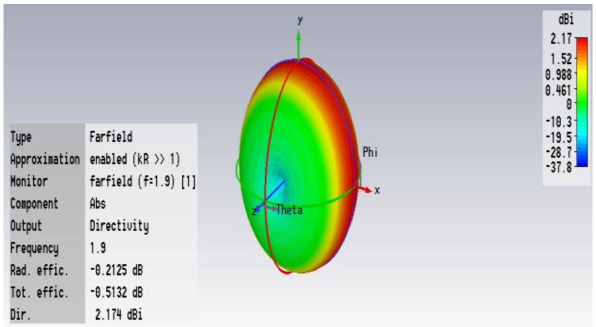

Fig.6: 3-D Radiation Pattern of patch Antenna at 1.995 GHz

5. Conclusion

A half-wave dipole antenna has been designed and simulated using CST Microwave Studio software. This is operating in the frequency band of 1.877 GHz to 2.1199 GHz covering GSM frequency range. The simulated impedance bandwidth at the 1.995 GHz band is around 0.2429GHz The simulated and measured results show that the antenna has perfect impedance matching. It is suitable for designing antennas for GSM applications. It's reasonable to assume that the antenna proposed in this paper can also be used for other potential applications.

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