Design of Multiband Microstrip Dipole Antenna for LTE, GSM, UMTS, LORA and WLAN Applications

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***Abstract*: In this paper, a multiband printed dipole antenna design and implementation for the LTE, GSM, UMTS, LORA and WLAN applications with improved radiation characteristics is presented. A simple centre feeding technique is used to feed the dipole, with input port connected between ground and antenna feeder point. The prototype of proposed antenna had been fabricated and tested to meet performance characteristics in terms of return loss (<-10dB), VSWR (<2) and Gain (around 2dBi). With achieved RL to be -20.85 dB for low band, -13.68dB for high band, VSWR to be 1.194 for low band, 1.63 for high band and gain to be 1.8dBi. The antenna designed is targeted to resonate at multiband such as 835MHz, 1.9GHz, 2.05GHz, 2.35GHz, and 2.55GHz with satisfactory radiation pattern and gain. The proposed design is validated to meet the required specifications. The design and simulation is carried out using high frequency EM simulator tool called Computer Simulation Technology (CST) and analyzed.**

Keywords- LORA, multiband dipole antenna, broadband dipole antenna.

I. INTRODUCTION

Antennas are indispensible components of wireless communication system. One such antenna type is printed-circuit-board (microstrip) antennas. In this avenue age of antenna technology the microstrip antenna, not only provide ease and flexibility, but also provide improved efficiency of extended applications. In this paper, the design of a multiband planar dipole for multiband antenna systems of compact size is proposed. With simple theoretical formulation of dipole antenna the corresponding dimensions are calculated with increased demand for smaller size and simple integration compared to other antenna types. These types of antenna are widely used in RF field because of their ease of fabrication and performance analysis. The dipole antenna is one such type for RF applications. These antennas can be used individually, or as a part of an antenna array of different type of radiating elements, that can operate up to ultra high frequency (UHF) range.

Apart from wide variety of dipole antenna, the half wave dipole is electrically half wavelength in dimension, normally fed at the middle where it encounters low impedance. Hence leading to a structure emphasizing two quarter wavelength elements in line with feeding point connected between them. In this paper we describe a multiband or more precisely dual band, dipole antenna with improved radiation characteristics, compact size and achieving high profile needs. The presentation of how the microstrip antenna design is carried out using 3D EM simulator (CST) is depicted in figure 1.

As a background for this work, Iswandi et al [1] designed and presented a Printed dipole antenna which is appropriate for base station characteristics that is compact enough, with low cross polarization, compatible for array arrangement. Ch. Person et al [2], presents their work on Multiband microstrip dipole antenna centered around 6 GHz. Subhasree S B et al [3] designed 8×2 and 4 ×4 dipole array antenna for dualband requirement, obtaining 4.9% bandwidth, VSWR < 1.5 and gain of 7.55 dB at 8.2 GHz, and 44.53% of bandwidth, VSWR < 1.5 and gain of 7.16 dB at 7.41 GHz respectively. M. E. Jalil et al [4] design implemented a multiband antenna using straight dipoles in ISM band. Fawwaz. J et al [5]. has design implemented a small size and multi-band cross dipole antenna on a fractal first iteration quadratic Koch curve. This work is carried out in the frequencies 1255 MHz, 2058 MHz, and 6450 MHz achieving the VSWR<2 and the reflection coefficient < -10dB .

II. METHODOLOGY

The design procedure of compact multiband dipole antenna at the following frequency sub-bands: 775MHz- 895MHz, 1.85GHz-1.95GHz, 2GHz-2.1GHz, 2.3GHz-2.4GHz, and 2.5GHz-2.6GHz is depicted in the flowchart of figure 1 below. Followed by orientation, shape, feeder location formulations, the antenna has been designed and fabricated. The aforementioned CST Simulation software is used to design and analyze the antenna parameters.

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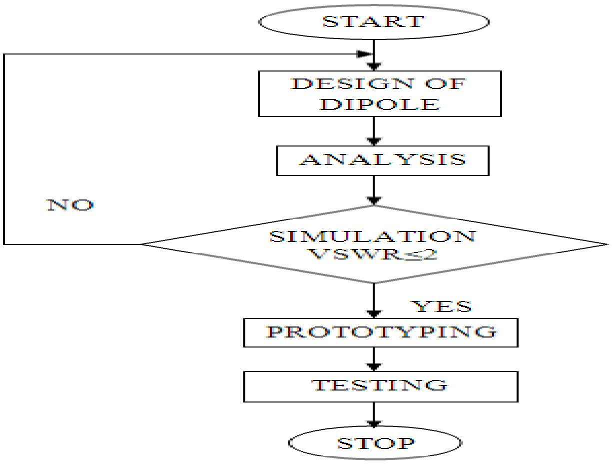

Figure 1: Flow chart of proposed antenna design simulation methodology.

III. DESIGN OF DIPOLE ANTENNA

A single layer printed circuit board [PCB] of FR4 substrate is used in order to fabricate. One arm of the antenna is printed on one side of PCB and other on contradictory flipside. The goal of multiband is achieved by printing single arm for lower narrow frequency band and multi arms for higher frequency bands. This composite microstrip leads to multiband radiation pattern, leading to desired specifications. The numerical values the parameters are as follows: Dielectric constant of substrate (FR4), ε_r = 4.4.

Height of Substrate, h = 1.6 mm, Let, velocity of light (c) = $3{\times}10^8$ m/s.

Operating Wavelength (mm), $\lambda_0=\frac{c}{f}$, Guide wavelength in dielectric (mm), $\lambda_d=\frac{\lambda_0}{\sqrt{\varepsilon_r}}$.

Length of dipole (mm) = $\frac{\lambda_d}{2}$, Width of dipole (mm) $=0.05 \times \lambda_d$.

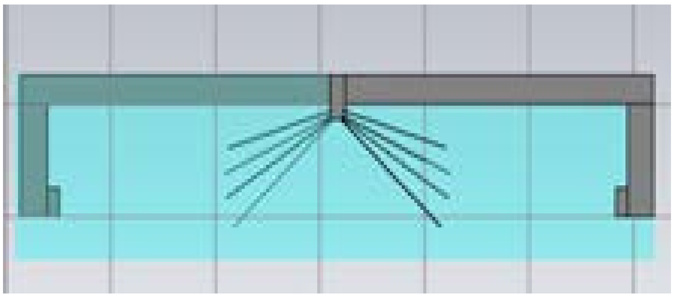

Figure 2: snapshot of proposed micro strip dipole antenna structure.

IV. Simulation Results:

The CST tool at a glimpse: CST software is a high-performance 3D EM (Electromagnetic) analysis software package for designing, analyzing and optimizing EM components and systems. EM solvers for applications across the EM spectrum are contained within a single user interface in CST studio suite. The solver can be coupled to perform hybrid simulations, giving engineers the flexibility to analyze whole system made up of multiple components in an efficient and straightforward way.

In order to deliver and receive high output power to an antenna, transmission line impedance should be well matched to antenna impedance. With other characteristics parameters like VSWR which depicts how efficiently power is transmitted from source to load through transmission line. Ideally it ranges from 1 to infinity but practically we consider VSWR to be less than 2 for perfect matching. Following VSWR verses frequency relation met for the proposed design is shown in figure 4.

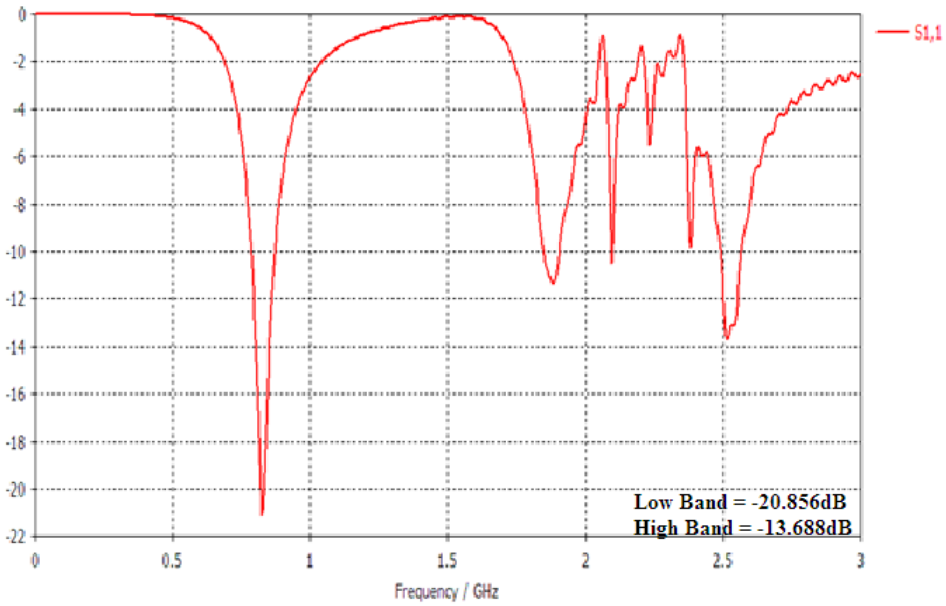

Figure 3: Return loss (RL) of the proposed micro strip dipole antenna

Return loss (RL) is power loss in reflected signal due to discontinuity in transmission line and mismatch with the inserted load in the line is expressed in dB. Hence simulated RL for the proposed deign is shown in figure 3. The RL is given by RL= -20 log [$VSWR-1/VSWR+1$].

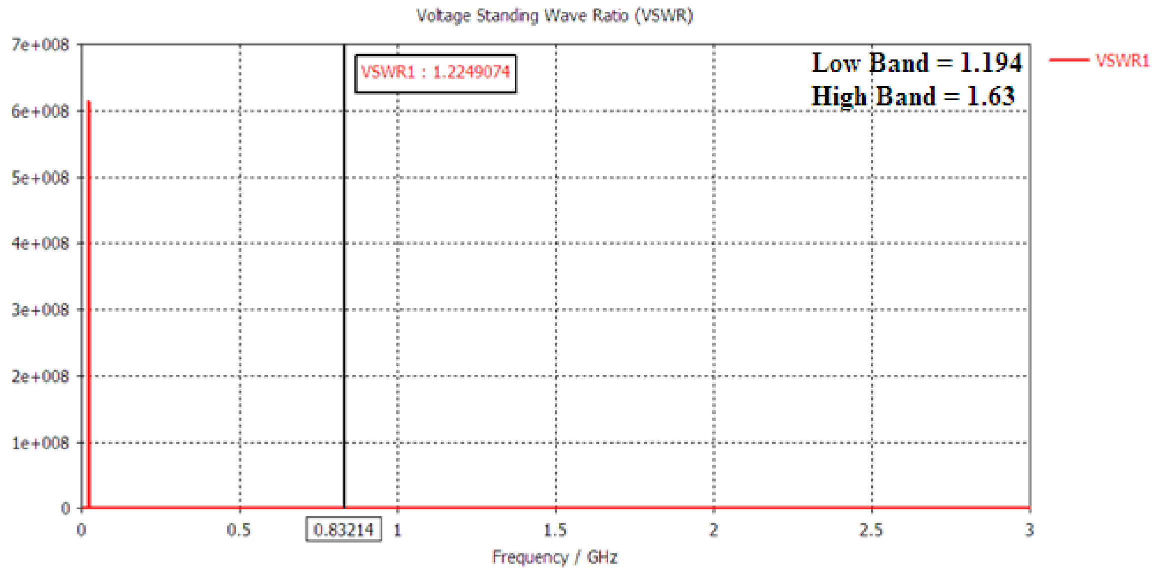

Figure 4: voltage standing wave ratio VSWR (<2) for the proposed micro strip dipole antenna over the frequency band of interest.

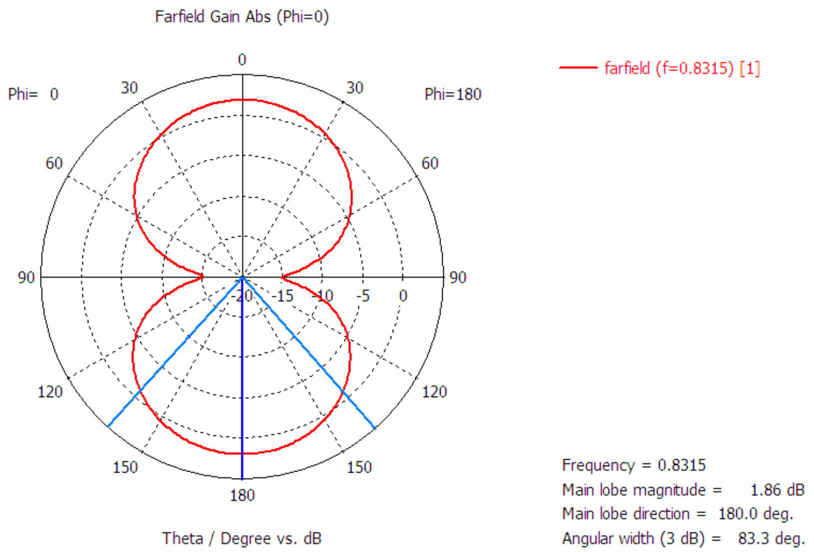

Figure 5: Far Field pattern of the proposed microstrip dipole antenna.

V. CONCLUSION

The Multiband band dipole antenna of 835MHz, 1.9GHz, 2.05GHz, 2.35GHz, 2.55GHz tuning frequency has been designed and all the technical specifications of return loss to be -20.856dB for low band (LB) and -13.688dB for high band (HB), VSWR to be 1.194 and 1.63 for LB and HB respectively had been met by varying length of micro strip antenna and ground using CST software. Hence the sequential steps followed by fabrication and testing had been carried out successfully.

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