Design of Multiband Antenna for Wireless Communication Applications

Yogesh Nawale[1] , Rekha P. Labade[2]
Department of E&TC Engineering
[1, 2]Amrutvahini College of Engineering,Sangamner, India.

Abstract-*In this paper, a design and investigation of Micrrotrip antenna for multiband operation has been suggested. Multiband monopole antenna working over GSM 800 MHz, Digital Communication System (DCS) 1800 MHz, 3G-2100 MHz and 4G-2300 MHz band applications has been researched. Designed antenna has size of 121mm x 111 mm and has been simulated over the CADFEKO EM Simulation tool. Proposed antenna has been simulated against frequency range of 0.5 GHz to 2.5 GHz operating region. Simulated antenna shows <-10 dB reflection coefficient bandwidth all over the different regions of operating bands and poses bigger than 75% of operating efficiency. Proposed antenna has been modeled with rectangular patch and slotting methods have been adopted for proper multiband operation. Antenna has been simulated with FR-4 dielectric substrate with effective dielectric constant of 4.4 and loss tangent of 0.02.*

Keywords-CADFEKO; multiband antenna; microstrip, rectangular patch; slotting

I. INTRODUCTION

In nowadays, radio wire configuration has gotten noteworthy significance. The outline of multi-band radio wire for 2.4 GHz Bluetooth IEEE 802.11 b/g (2.4–2.484 GHz), 3.5 GHz WiMAX IEEE 802.16 (3.4–3.6GHz), 5.2/5.8GHz WLAN IEEE 802.11 a (5.15–5.35 GHz and 5.725–5.825 GHz) and 5.5 GHz HIPERLAN2 (5.47–5.725 GHz) because of its extensive variety of ease of use in all business specialized gadgets, for example, advanced cells, portable PCs, tablets, phablets, and so forth is particularly requesting [1]-[3].

Antennas, an indispensable piece of such remote correspondence frameworks, are subjected to extremely stringent determinations, for example, light weight, conservative structure, low profile, power and acclimate capacity and are relied upon to get however much range as could be expected to give multi-band or broadband operation [1]. The plan of a few multi-band recieving wire fulfilling some of these details have been accounted for in [5]

In any case, joining of these reception apparatuses with RF-MIC circuits with restricted access to just administration in WiMAX/WLAN recurrence groups is a troublesome undertaking. Hilter kilter coplanar strip (ACS) sustain multiband radio wires give simple coordination arrangements RF-MIC have been accounted for in [5]. As a rule, an ACS bolster radio wire gives around half size lessening contrasted with the conventional CPW sustain reception apparatus as just a single a large portion of the ground plane of the CPW structure is considered [6].

Microstrip antenna system offers good remedy for multiband feasibility in the current application scenario of wideband communication systems. Microstrip antenna configuration supports low weight, moderate gain, high bandwidth and conformal distinct features and hence the high frequency modeling of microwave system can be easy to exhibit.

Proposes antenna has been simulated at multiband operating characteristics of application and has been carried out with microstrip feeding technologies. Size deduction of total geometry has been proposed and simulated results have been described in the next sections.

II. ANTENNA DESIGN

Proposed multiband antenna has been designed by using transmission line formulae for antenna design [3], [5]-[6]. Designed antenna has been simulated by using FR-4 substrate having dielectric constant of 4.4, loss tangent 0.02 and effective dielectric constant of 3.88 with substrate thickness of 1.6 mm. Antenna parameters for multiband operation has been summarized in table I. Designed antenna geometrical specifications are shown in fig. 1.

In order to incorporate the multiband operation in the existing antenna several techniques have been proposed by researchers out of which following techniques are prominently used: Using parasitic elements along the radiating patch, using slots in either radiating patch or ground plane, changing feeding mechanism, using beveling structures in the radiating patch, changing the dimensions of the radiating patch.

Operating Wavelength (λ) = $\frac{C0}{F*\sqrt{\in r}}$ (1)

Patch Width $(w) = \frac{\lambda}{4}$ (2)

Patch Length $(l) = \frac{C}{4f} * \sqrt{\frac{2}{\epsilon r+1}}$ (3)

Table 1 Antenna Design Parameters

meters	Calculated values
Resonance frequency (Fr)	0.5 GHz to 2.5 GHz
Lower Egde frequency (f)	1.1 GHz
Relative permittivity of substrate (εr)	4.4
Loss tangent (tanδ)	0.02
Substrate height (h)	1.6 mm
Effective dielectric constant (εreff)	3.88
Wp (Width of patch)	114
Lp (Length of patch)	89.16
Wsub (Width of substrate)	121.4
Lsub (Length of substrate)	111.72
Wg (Width of ground)	121.4
Lg (Length of ground)	111.72
Wf (Width of feedline)	3
Lf (Length of feedline)	22.5

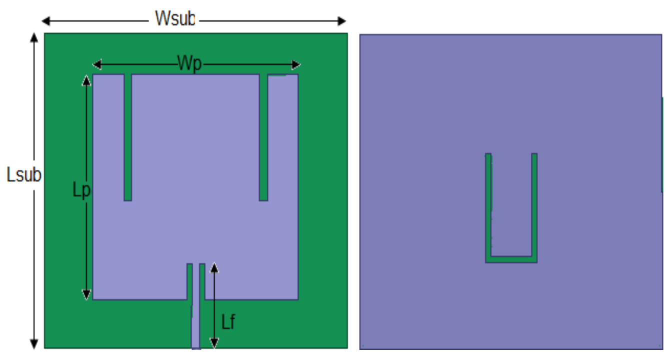

Fig. 1. Simulated antenna geometry.

Simulated antenna geometry shown in fig. 1 and has been evaluated and developed in method of moment (MOM) based cadfeko antenna simulation tool [4]. Proposed antenna has microstrip feed of 3 mm x 22.5 mm giving the conformal geometry for MMIC applications of proposed antenna. Rectangular slot over the patch has been placed as per current distributions to achieve the proper UWB portioning over the band of 3.10 GHz to 10.60 GHz operating band.

III. RESULTS AND DISCUSSIONS

Proposed antenna has been simulating against the multiband frequencies with rage of 1 GHz to 6 GHz and analyzed against various parameters including reflection coefficient, Voltage Standing Wave Ratio, Impedance magnitude, Co and Cross polarizations, Gain, efficiency and so on.

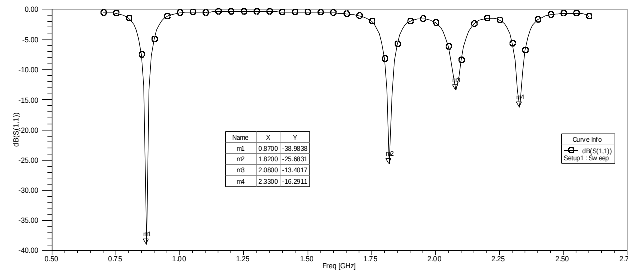

Fig. 2. Reflection coefficient magnitude of proposed antenna.

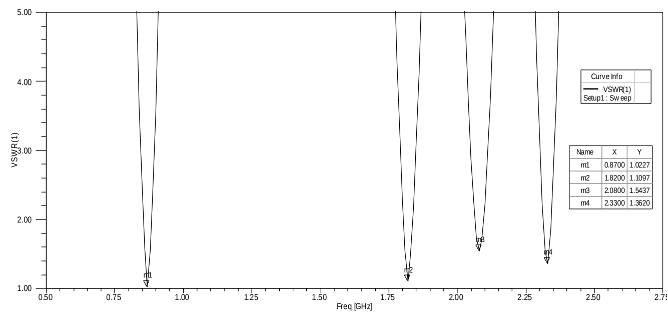

Fig. 3. VSWR magnitude of proposed antenna.

shows the simulated return loss of the proposed multiband antenna. The simulated return loss shows the multiple resonance frequencies available at covering the GSM 800, GSM 1800, 3G and 4G frequency bands. The high isolation between intermediate bands further makes the antenna a more valid candidate for mobile applications, thus minimizing the need of filters.

VSWR magnitude of proposed multiband antenna is shown in fig. 3. VSWR parameter measures a standing wave ratio when antenna is mismatched to its load. Simulated antenna achieves good matching behavior and provides 5.11 GHz of VSWR bandwidths at simulating frequencies.

Fig. 4. shows the variation of impedance against frequency. The impedance at the resonance frequencies of the proposed antenna has characteristic impedance (Z0) of 50Ω. the resonance frequencies of the proposed antenna.

Simulated antenna effectiveness in terms of efficiency is shown in fig. 5. Simulated antenna has approximately 75% of effectiveness at simulating UWB frequencies.

Radiation patterns of simulated antenna have been shown in fig. 6. Simulated antenna challenges > 20 dB co-polarized operation and > 19 dB cross polar operations at faded wireless channel. Simulated antenna shows omnidirectional radiation pattern at E-plane and directional radiation pattern at H-plane of propagation.

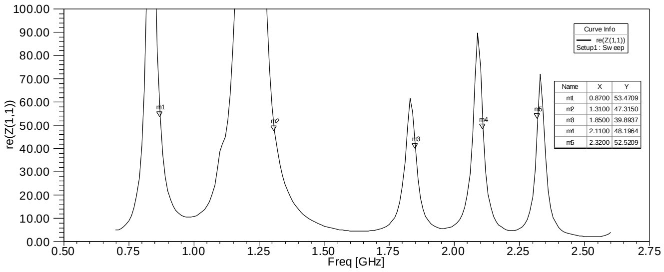

Fig. 4. Impedance magnitude of proposed antenna.

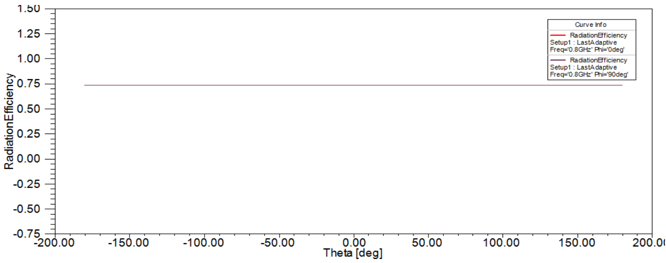

Fig. 5. Simulated efficiency of proposed antenna.

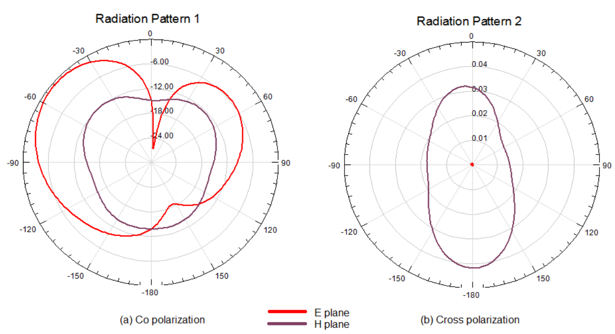

Fig. 6. Radiation Patterns of proposed antenna.

Fig.7. through 10. show the simulated surface current distribution at the sampling frequency of 800 MHz, 1800 MHz, 2100 MHz and 2300 MHz. The surface current mainly concentrated along the radiating patch and ground plane at the fundamental frequency of 800 MHz which marks the fundamental frequency of the proposed multiband antenna. The surface current distribution slights detoriates as the operational frequency goes on increasing.

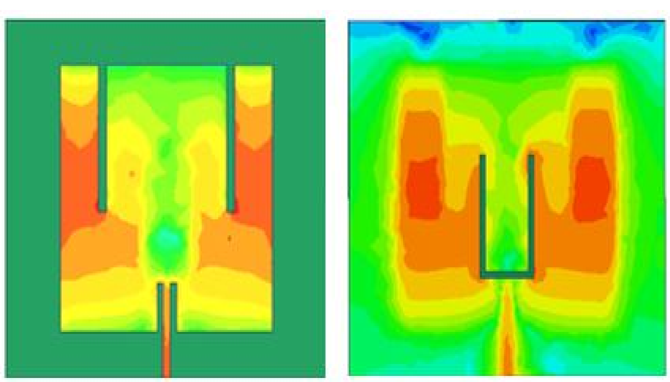

Fig.7 . Simulated surface current distribution at 800 MHz

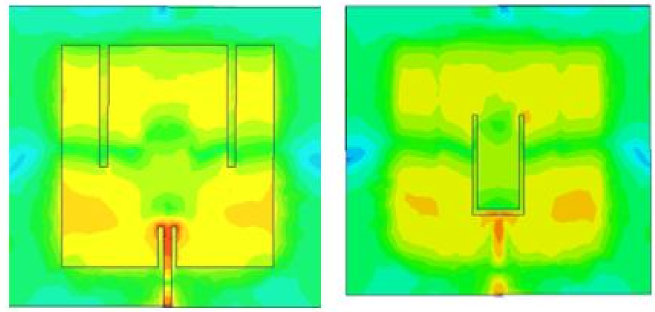

Fig. 8. Simulated surface current distribution at 1800 MHz

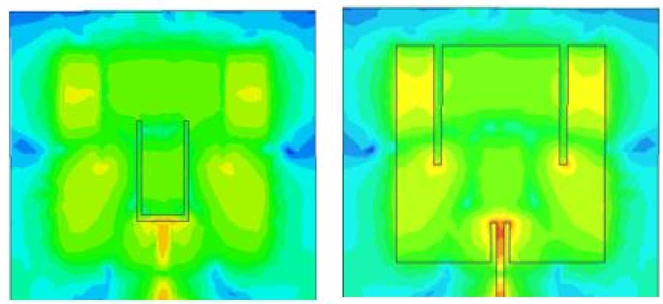

Fig. 9. Simulated surface current distribution at 2100 MHz

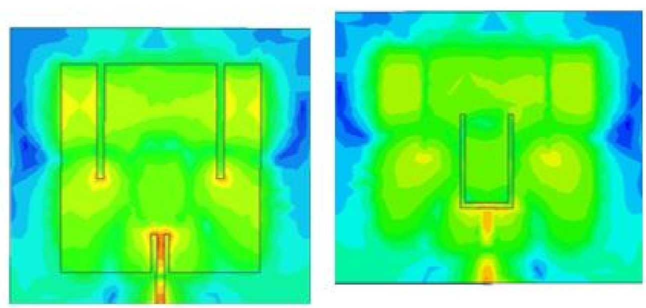

Fig. 10. Simulated surface current distribution at 2300 MHz

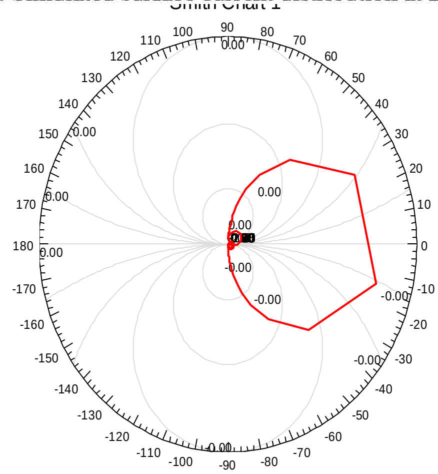

Fig. 11. Smith chart.

Fig. 11 shows equivalent impednace smith chart plot of the proposed antenna.

IV. CONCLUSION

A design and implementation of multiband antenna for mobile wireless communication application has been presented. The proposed antenna thus supports operation in GSM 800 MHz, GSM 1800 MHz, 3G(WCDMA) 2100 MHz and 4G(LTE) 2300 MHz making it a suitable candidate for mobile communication applications, data dongles, etc. Simulated radiation efficiency of the proposed antenna is about 75% across all frequencies. The radiation patterns modulated antenna are nearly directional along E plane and omni directional along the H plane at all the simulated frequencies

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