Inset fed Triple Band U-Slot Antenna for GSM900/GSM1900/WLAN Applications

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Abstract:—To cover Global System for Mobile Communication(GSM) and WLAN frequency bands, three distinctive Inset fed antennas like rectangular microstrip, dualband dual slot and antennas are designed. Inset fed microstrip antenna is used for GSM1900 with an impedance bandwidth from 1.90GHz to 1.96GHz. Inset fed dual band dual slot antenna is used for GSM1900 and WLAN with impedance bandwidth is considered first band from 1.90GHz to 1.95GHz and second band from 2.38GHz to 2.42GHz. The proposed Inset fed triple band antenna is used for GSM900, GSM1900 and WLAN with appropriate position of slot, is to operate in frequency ranges of first band is from 920MHz to 940MHz, second band is from 1.91GHz to 1.94GHz and third band is from 2.39GHz to 2.43GHz. A correlation among various feed widths, feed lengths and slot widths are exhibited in this paper.

Keywords—Inset fed, Triple band, Dual band, Slot antenna, HFSS, Patch antenna, GSM, WLAN.

I. INTRODUCTION

In present days, design of dual band and triple band patch antennas are highly desirable for wireless communication applications. Patch antennas inferable from their favorable circumstances, for example, low profile, reasonable to produce, light weight and simple to create. Inspite of these points of interest, there are not many inconveniences like limited bandwidth, less power dealing with limit in patch antennas [1-2]. For the most part patch antennas work in various frequency bands, separate antennas are used to cover each band which prompts space-confining issue. One approach to satisfy this necessity is utilizing various antennas, yet it will build the size and intricacy of the system. To overcome this issue, slot antennas are required which gives dual band and triple band frequencies using single antenna with appropriate slot position. From now on it diminishes the system size and multifaceted nature [3]. Large bandwidth can be achieved by adjusting the slot dimensions, which include different shapes like rectangular, triangular, circular [4], elliptical [5], triangles [6] are reported. To achieve dual band operation edge feed has been used [7]. Multi service wireless system, Wide band or dual band and triple band antennas are needed[8-11].

To obtain dual band and triple band behavior in patch antennas by providing slot and excite the antenna in orthogonal direction or Y-shape using microstrip line feeds[12-14]. Regardless, these dual band and triple band

slot antennas are large in size, most of the wireless applications minutarized antennas are needed. In literature designed edge cut dual band slot antenna, which finds applications in Bluetooth/WLAN and WiMAX [15] and Corner cut Insetfed dual band slot antenna for PCS and Bluetooth/WLAN Applications [16] which improves the impedance matching.

A novel design of Inset fed triple band U slot, Insetfed dual band dual slot and Inset fed microstrip antennas were presented. These antennas are little in size, straightforward development and minimal effort. By providing inset feed to these antennas better impedance matching is achieved. Dual band and triple band operation is obtained with appropriate slot dimensions, which find applications in GSM and WLAN. The VSWR, return loss, peak gain, peak directivity, radiation pattern and radiation efficiency are explained as well as design details of these antennas are discussed in this paper.

II. ANTENNA CONSTRUCTION AND DESIGN

The Inset fed microstrip antenna geometry is showed up in fig.1, Inset fed dual band dual slot microstrip antenna configuration is showed up in fig. 2, and Inset fed tripleband U slot microstrip antenna structure is showed up in fig.3.

Fig. 1. Inset fed microstrip antenna

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Fig. 2. Inset fed dual band dual slot antenna

Fig. 3. Inset fed Triple band U slot antenna

These three Inset fed antennas are designed utilizing FR4 substrate with height 1.6mm having $\epsilon_r=4.4$ and $\tan\delta=0.02$. To match the impedance 50Ω strip line is used. All antenna parameters are simulated using HFSS and antenna dimensions are shown in table I.

Table1: Antenna design parameters

Parameter	Inset fed Triple band U slot antenna (mm)	Inset fed Dual band Dual Slot Antenna (mm)	Inset fed Rectangular Antenna (mm)
Patch Length (L)	36	36	36
Patch Width (W)	48	48	48
Feed Length (F_L)	25	25	25
Feed Width (F_W)	2.8	2.8	2.8
Inset feed Length (I_L)	5	5	5
Inset feed Width (I_W)	4	4	4
Slot Length (S_{L1})	27	24	—
Slot Length (S_{L2})	40	—	—
Slot Width (S_W)	1.5	2	—

III. SIMULATION RESULTS AND DISCUSSION

The Inset fed microstrip antenna is worked among 1.90GHz to 1.96GHz with center frequency 1.93GHz, return loss -20.12dB is showed up in fig. 4 and VSWR 1.22 is showed up in fig. 5, peak directivity 2.48, radiation patterns are showed up in fig. 13, peak gain 1.17 and radiation efficiency 48%. This antenna effectively used in GSM1900 band.

Inset fed dual band dual slot antenna is considered as first band among 1.90GHz to 1.95GHz with center frequency 1.92GHz, return loss -12.97dB is showed up in fig. 6, and VSWR 1.5 is showed up in fig. 7, and second band is from 2.38GHz to 2.42GHz with center frequency 2.4GHz, return loss -16.93dB is showed up in fig. 6, and VSWR 1.33 is showed up in fig. 7, radiation patterns are showed up in fig.14, peak directivity 2.53, peak gain 1.24 and radiation efficiency 49%. This antenna effectively used in GSM1900 and WLAN bands.

The proposed Inset fed triple band U slot antenna is considered lower band among 920MHz to 940MHz with center frequency 930MHz, return loss -16.38dB is showed up in fig.8, and VSWR 1.36 is showed up in fig. 9, and middle band is from 1.91GHz to 1.94GHz with center frequency 1.93GHz, return loss -15.84dB is showed up in fig. 8, and VSWR 1.39 is showed up in fig. 9, and upper band is from 2.39GHz to 2.43GHz with center frequency 2.41GHz, return loss -14.88dB is showed up in fig. 8, and VSWR 1.44 is showed up in fig. 9, peak directivity 2.54, radiation patterns are showed up in fig.15, peak gain 1.11 and radiation efficiency 43.79%. This antenna effectively used in GSM900, GSM1900 and WLAN bands.

For Inset fed triple band antenna, good impedance matching is achieved at feed length $F_L=25\text{mm}$ as compared to $F_L=24\text{mm}$ and $F_L=26\text{mm}$ is showed up in fig. 10. Good return loss obtained in all bands at feed width $F_W=2.8\text{mm}$ as compared to $F_W=2\text{mm}$ and $F_W=3\text{mm}$ is showed up in fig. 11. Desired bandwidth is obtained in three bands at slot width $S_W=1.5\text{mm}$ as compared to $S_W=1\text{mm}$ and $S_W=2\text{mm}$ is showed up in fig. 12.

Fig. 4: Return loss (S11) of an Inset fed microstrip antenna

Fig. 5: VSWR of an Inset fed microstrip antenna

Fig. 6: Return loss (S11) of an Inset fed dual band dual slot antenna

Fig. 7: VSWR of an Inset fed dual band dual slot antenna

Fig. 8: Return loss (S11) of an Inset fed triple band U slot antenna

Fig. 9: VSWR of an Inset fed triple band U slot antenna

Fig. 10: Return loss (S11) comparison of different feed lengths of an Inset fed triple band U slot antenna

Fig. 11: Return loss (S11) comparison of different feed widths of an Inset fed triple band U slot antenna

Fig. 12: Return loss (S11) comparison of different slot widths of an Inset fed triple band U slot antenna

Fig. 13: Radiation pattern (GAIN) of a rectangular microstrip antenna

Fig.14: Radiation pattern (GAIN) of an Inset fed dual band dual slot antenna

Fig. 15: Radiation pattern (GAIN) of an Inset fed triple band U slot antenna

IV. CONCLUSION

Antennas are simulated at specified frequencies and antenna parameters are explained. The Inset fed triple band antenna is to operate in three specified bands in which the lower band with center frequency 930MHz which meet the requirement of GSM900, middle band with center frequency 1.93GHz which meet the requirement of GSM1900 and upper band with center frequency 2.41GHz which meet the requirement of WLAN, The Inset fed dualband dual slot antenna is to operate in two specified bands in which first band with center frequency 1.92GHz which meet the requirement of GSM1900 and second band with center frequency 2.4GHz, which meet the requirement of WLAN. The Insetfed microstrip antenna is to operate at center frequency 1.93GHz, which finds the application of

GSM1900. Every one of the three antennas has over 43% efficiency with least peak directivity 2.48.

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