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U-Slot Dual-Band Planar Inverted-F (PIFA) for 5G in Sub-6 Ghz Spectrum Bands

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***Abstract:** Salonen P., was the one who first proposed the idea of Double band performance of a planar reversed F antenna utilizing a U-shaped slot with a planned use for Wireless LAN at 2.4/5.2 GHz (IEEE 802.11b/a). The lower and upper frequency bands basically depends on and essentially controlled by the measurement of the external and internal plate separately. This design is normally implemented in places where there is a strong limitation in terms of space and also where the design can operate in multipath environment circumstances, something similar to mobile phones and wireless LAN operation environments. The performance of this and the related minimized designs are normally poor in contrast to the bigger and customary designs. The radiation pattern example and method of operation are not very much characterized, particularly for the upper design band, where the radiation pattern will in general stray from omnidirectional and changes quickly with frequency. In the geometry utilized here, the short is set unevenly as an afterthought confronting the upper finish of the U-shaped opening. In any case, there are various conceivable feed/short setups.*

***Index Terms:** Dual-band, IEEE 802.11b/a*

I. INTRODUCTION

The heft of future 5G systems will probably comprise of the "sub 6GHz" mid-band gathering, which envelops everything somewhere in the range of 1 and 6GHz.This is now a sensibly blocked territory of range, as 2.4GHz and 5 GHz Wi-Fi and 2.45GHz Bluetooth sit in this range, as do numerous 4G LTE groups. In that capacity, quite a bit of this new range will show up in the 3 to 4GHz territory, sitting right in the middle of current Wi-Fi and LTE systems to stay away from clog issues. The last round of 2018 range barters over the globe saw enormous deals in this 700MHz to 4GHz groups. The U.S. is taking a marginally unique way with a substantial mm Wave push, however various nations are starting to design their own extremely high-recurrence range sales sometime later. Obviously, this information will change as system administrators and controllers refine their 5G designs in the coming years, with due importance given to the antenna design along with spectrum finalization with minimum or suppressed mutual coupling between antenna elements[1]. Also the application should cover medical sector with utmost care which may lead to implementation of wearable antennas for patient monitoring system [2] [3].

II. PHYSICAL DESCRIPTION

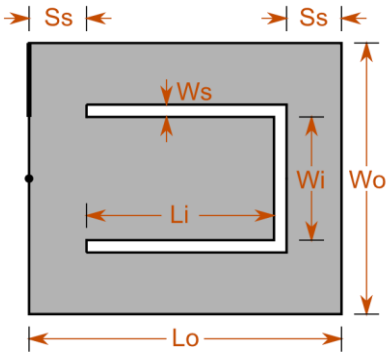
The physical description of the PIFA comprises of a rectangular plate above a ground plane, where the plate is shorted on the one side. A U-shaped slot defines an inner element which is responsible for the second operating band. The plate may be supported by small plastic spacers or low permittivity foam.

Table 1, depicts the physical description of the design which has been proposed in this paper for sub 6 GHz band.

Table 1: Antenna Structure: Antenna Parameters

Name	Description
f_{o1}	First operating frequency
f_{o2}	Second operating frequency
Df	Diameter of feed pin
H	Plate height
Li	Inner element length
Wi	Inner element width
Lo	Outer element length
Wo	Outer element width
Wsh	Width of shorting plate
Ws	Slot width
X	X-dimension of the Device
Y	Y-dimension of the Device
Z	Z-dimension of the Device
Ss	Slot offset

II. SKETCHES



A) Top view

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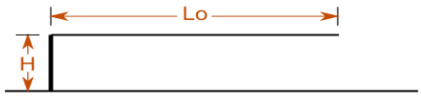
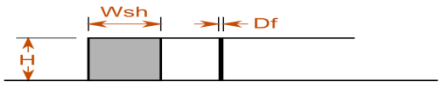
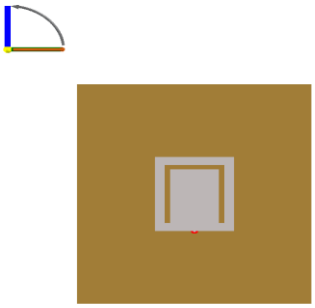


B) Front view



C) Side view



D) Top Side Preview
Fig1

Fig 1 shows the top, side, front view along with top side preview with proper measurements of the design mentioned. Suitable optimization has been done in the design stage so that the above said design delivers better performance in terms of gain and efficiency.

Table 2: Physical Parameters

Name	Description	Value
Df	Diameter of feed pin	448.9 µm
H	Plate height	4.489 mm
Li	Inner element length	10.77 mm
Wi	Inner element width	7.630 mm
Lo	Outer element length	14.96 mm
Wo	Outer element width	12.47 mm
Wsh	Width of shorting plate	4.440 mm
Ws	Slot width	897.9 µm
X	X-dimension	12.47 mm
Y	Y-dimension	14.96 mm
Z	Z-dimension	4.489 mm
Ss	Slot offset	1.646 mm

Whereas Table 2, depicts the dimensions of the design after optimization has been done for better precise performance.

III. FEED METHOD

The type of feed used in the design is co axial feed. The inner conductor of the coaxial feed passes through the substrate and is connected to the radiating plate. Whereas the outer conductor is directly connected to the ground plane structure.

IV. OPERATION MECHANISM

Planar PIFA's are similar to conventional inverted-F antennas where the radiating element has been expanded to form a plate [6]. They can also be considered to be variants of quarter-wave patch antennas with air dielectrics. The U-slot PIFA designed here has an inner element which is responsible for the extra peak at higher frequency. In antenna design the slot plays a significant role in creating a design with multiple resonant frequencies.

V. PERFORMANCE

The performance of this antenna is inferior when compared with less compact antennas. In many cases, acceptable performance of PIFA variants antennas is achieved at the expense of good S11. Above all the design is chosen for application despite the performance is inferior to that of the conventional design is specifically based on its small size and S11 which is more superior to older designs.

VI. IMPEDANCE CHARACTERISTICS

This antenna works above resonance, where the large reactive component of the input impedance approaches zero. At this point, the large real input impedance has reduced to around 50 Ω. The ground-plane measurements is very sensitive to the input impedance. Impedance bandwidths (-10 dB) in the range 1 – 3% are typical.

VII. RADIATION CHARACTERISTICS

The radiation patterns of the two frequencies differ from one another and are not well behaved [4]. In addition, the pattern may have significant cross-polarization. However, in a typical operating environment, this is unlikely to be a problem since multipath effects often dominate. Moreover, when used in a mobile phone, the proximity of a user's head and hand significantly perturbs the radiation pattern and reduces efficiency [5].

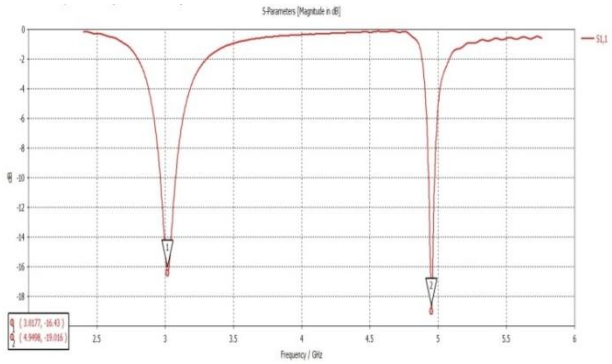


Fig 2: S- Parameters

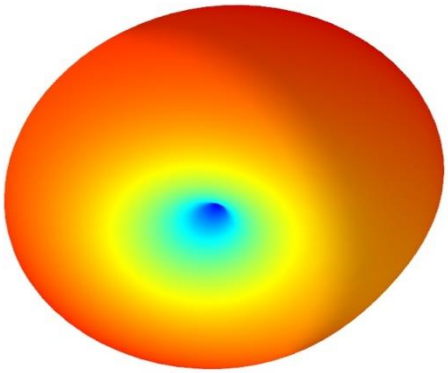
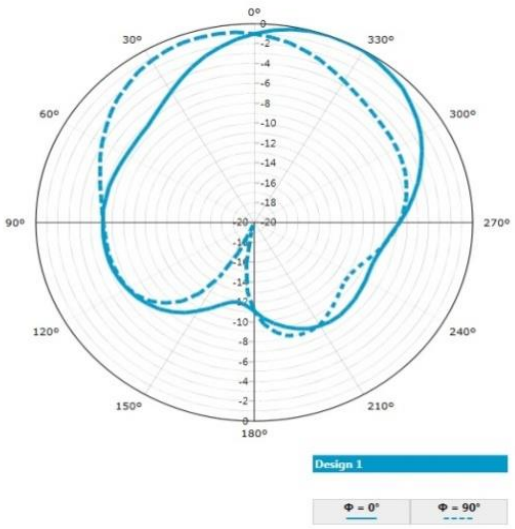


Fig 4



a

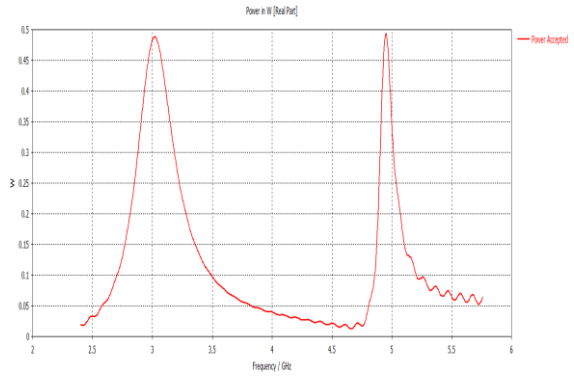


Fig 5

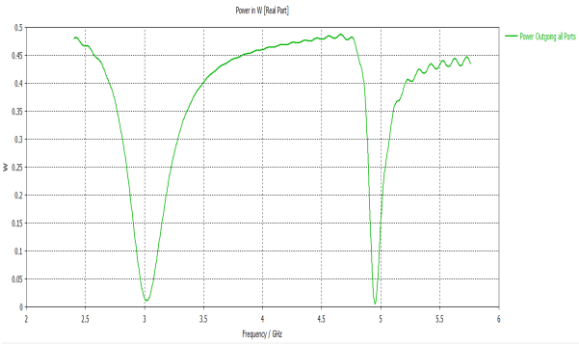
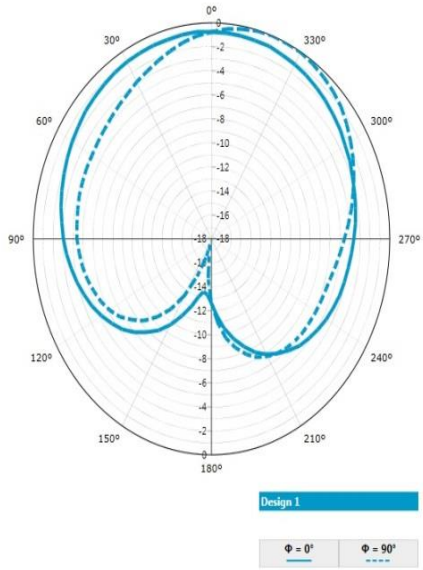


Fig 6



b

Fig 3

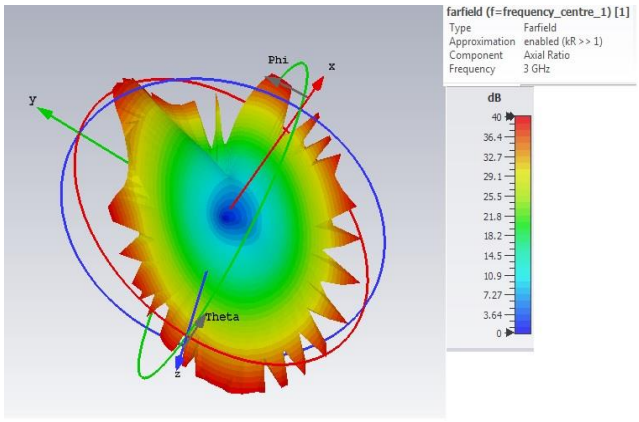


Fig 7

Fig 2 , Fig 3 and Fig 4 represents the S- parameter plot along with radiation pattern for different phase angles.

Fig 5 and Fig 6 shows the power accepted and power outgoing from the antenna perspective.

Fig 7 represents the gain attained by the antenna for the dual band of frequencies.

VIII. RESULTS AND DISCUSSION

For the above mentioned design it has been found that the reflection coefficient has been -16.43 dB for 3 GHz and -19.016 dB for 4.8 GHz bands. Also it's been found that the gain is 40 dB maximum for the proposed design.

IX. CONCLUSION

For the above Double band activity of a planar reversed F reception apparatus utilizing a U-formed opening the performance has been analyzed based on S- parameters and Gain attained in the designated frequency band of 3 GHz and 4.8 GHz and it has been found that it performs well based on the required expectations from the design. The above design can be further fine-tuned so that its performance in all aspects which has not been included in this paper can be optimal.

REFERENCES

1. R. Darwin, S. Swaati, G. Swathi, R. Vishnu Priya "Suppression of Mutual Coupling between Dual Element MIMO Antenna for 5G", International Journal of Innovative Technology and Exploring Engineering (IJITEE), Vol -8, Issue 2S2, pp. 187-191, 2018.
2. R. Darwin and S. Vinodhini "Design of Multiband Wearable Rectangular Slot Antenna for WIMAX and WLAN Applications", International Journal of Innovative Technology and Exploring Engineering (IJITEE), Vol -8, Issue 2S2, pp. 216-220, 2018.
3. R. Darwin and G. Ishwarya, "Dual Band MIMO Antenna using Decoupling Slots for WLAN Applications", Journal of Advanced Research in Dynamical and Control Systems, pp. 1138-1147,2017.
4. C. R. Rowell and R. D. Murch, "A capacitively loaded PIFA for compact mobile telephone handsets," IEEE Trans. Antennas Propagat., vol. 45, pp. 837–841, May 1997.
5. K. L. Virga and Y. Rahmat-Samii, "Low profile enhanced-bandwidthPIFA antennas for wireless communications packaging," IEEE Trans.Microwave Theory Tech., vol. 45, pp. 1879–1888, Oct. 1997.
6. C. R. Rowell and R. D. Murch, "A compact PIFA suitable for dualfrequency900/1800-MHz operation," IEEE Trans. Antennas Propagat.,vol. 46, pp. 596–598, Apr. 1998.