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# Dual band biplanar quasi-Yagi antenna with inset feed

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**Abstract**

In this paper a quasi-Yagi antenna is presented. The active element is bi-planar with a reflector and two directors. Antenna works in dual band at operating frequencies of 2.65 GHz and 4.98 GHz. Maximum bandwidth obtained is about 30%. Antenna impedance is near to 50 ohms at the operating frequencies. A uniform gain of about 6 dB is observed from a range of 2 GHz to 3.5 GHz. Since the antenna is using 2 parasitic elements we obtain a very good directivity and bandwidth. Front to back ratio is 5.5. Return loss achieved at the two operating frequencies is -23 dB and -28 dB. VSWR is way below 2. Radiation efficiency is 87%. Dimension of the substrate over which the antenna is fabricated is 49mm x 65mm x 0.8mm. The presented antenna can be very useful in WiFi and WiMax applications. The antenna design is very simple as compared to its simulated performance. Simulation is done on EM-CAD tool HFSS 11.1.

***Keywords:*** *quasi Yagi, Return Loss, VSWR, input impedance, front to back ratio.*

## 1. Introduction

With the growth of the development of printed antenna researcher have started searching for the ways to use the features of old legendary antennas in this technology. As a consequence, the most famous antenna design of its time, Yagi-Uda antenna is printed on a dielectric substrate in several works [1], [2], [3] and others. Printed antenna has usually a narrow bandwidth. This problem is taken care of by printing Yagi antenna on a substrate. Since then many efforts are done on modifying these antenna to use them in various frequency range.

Yagi Uda antenna was discovered by Shintaro Uda and Hidetsugu Yagi and hence known as the Yagi-Uda antenna. It is a highly directive antenna containing only one driven element and other parasitic elements [9]. Driven element is mostly a wire based half wave dipole or a folded dipole. Parasitic elements contain one reflector which is greater in length than driven element (typically 0.55λ) and there can be many driver elements with size of the order of 0.45λ. The distance between them is 0.15λ-0.25λ. Reflector serves the purpose of reflecting the radiations of the active element towards the front and thus reducing lobes at the back. Directors induce the radiations from the active element and make the overall radiation pattern pointing in one direction. This antenna was meant to be an RF antenna but with improvements in technology researchers are able to use the feature of this antenna in higher frequency applications.

The presented work attempts to use the directive and high bandwidth features of Yagi antenna for ISM band.

Another league of antenna inspired by Yagi antenna was started by Qian et al [10]. They called it quasi-Yagi antenna. In the presented work, the two poles are on two sides of the substrate. The reflector is connected to one of the poles. The two directors are on the same side of the substrate where the reflector is present. Antenna is fed with inset Microstrip line.

## 2. Antenna Geometry

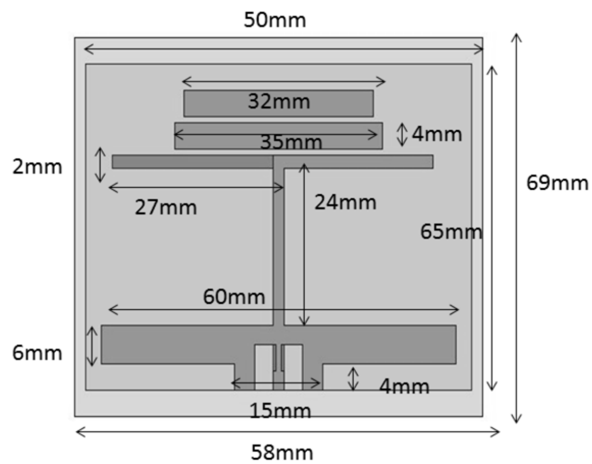


Fig. 1 Proposed antenna design

### 2.1 Active element

Active element is made up of two L-shaped structures 2 mm width each on the two sides of the substrate. It can be considered a dipole separated by a substrate. Longer side is 34 mm and smaller side is 27 mm of the L-shape.

### 2.2 Reflector

Reflector is a 6 mm wide and 60 mm long. It is 24 mm away from the active element.

### 2.3 Directors

There are two directors 4 mm wide each. Length of nearer one is 35 mm and farther one 32 mm.

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### 2.4 Feed

Inset feed is used. Feed is connected to the reflector as well as the active element. The inset is 7 mm inside from the edge. Notch width is 3.5 mm.

Since the presented antenna is a quasi-Yagi antenna, the reflector is away from the active element as compared to the directors. The reason behind this is that the field flowing in the active element gets out of phase with field of the element. [5]

## 3. Simulation Results

### 3.1 Return loss

Efficiency of an antenna at a given frequency can be estimated by measuring the return loss (i.e. S11 parameter). Return loss of an antenna tells how much supplied power is not used by the antenna. The proposed dual band directional antenna has two return losses of -22.95dB at 4.98GHz and -27.92dB at 2.65GHz.

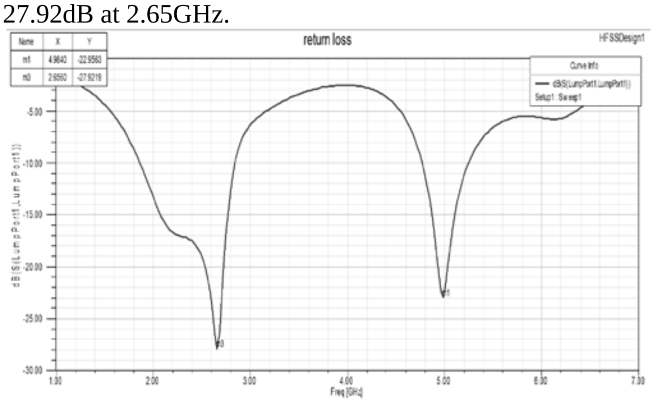


Fig 2. Return Loss

### 3.2 Bandwidth

The bandwidth of an antenna refers to the range of frequencies over which the antenna can operate correctly. Using tools like HFSS the bandwidth is calculated from S11 graph. -10 dB is taken as the reference and the first and the second intersection of the return loss curve with -10 dB line is taken as $f_L$ and $f_H$ respectively. The center frequency $f_C$ is 4GHz and the bandwidth is given by $[f_H - f_L]$. The bandwidth of the proposed antenna is 960 MHz & 456 MHz at 2.65 GHz and 4.98 GHz respectively.

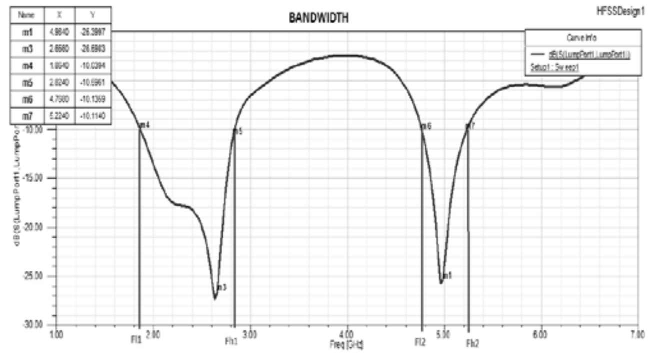


Fig 3. Bandwidth at two operating frequencies

### 3.3 Input Impedance

Input Impedance of the antenna is the impedance at its terminals or the ratio of the voltage to current at a pair of or the ratio of appropriate components of the electric to magnetic fields at a point. The input impedance of an antenna should be such at it is easily fed and is real rather than complex. Input impedance of the proposed antenna is 53Ω and 45Ω at 2.65GHz and 4.98GHz respectively.

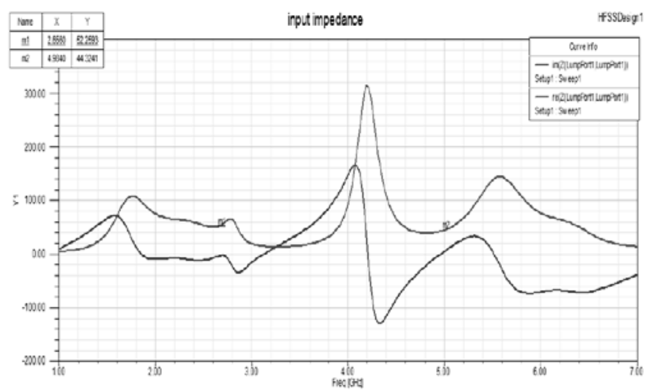


Fig 4. Input impedance vs. frequency

### 3.4 Voltage standing wave ratio (VSWR)

VSWR (Voltage Standing Wave Ratio) is also an important parameter which gives an estimate of the amount of power reflected to the transmission line that is feeding the antenna. VSWR ideally should be 1 means no power is reflected from the antenna. VSWR of the proposed antenna are 1.101 and 1.153 at 2.65 GHz and 4.98 GHz respectively.

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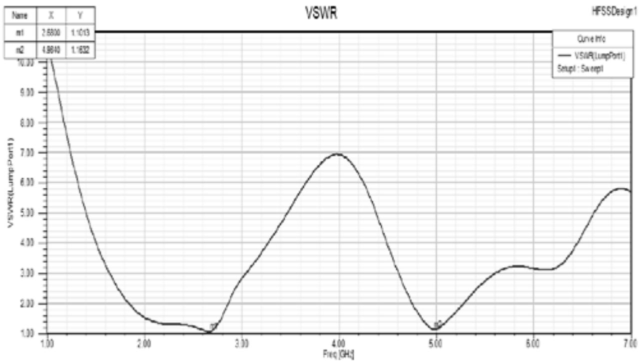


Fig 5. VSWR

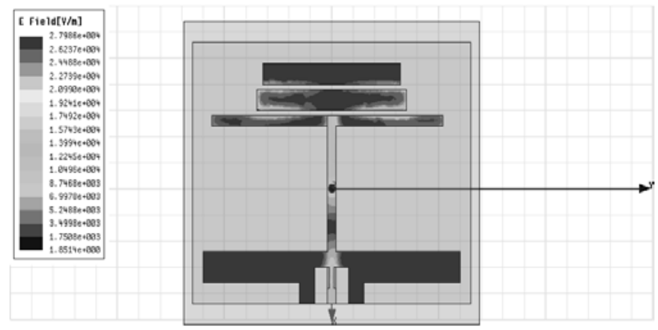

Fig 8. E-Field magnitude plot

### 3.5 Radiation Pattern

As expected, the radiation pattern of the designed antenna is directional. Its major lobe is directed away from the reflector. The antenna is firing from the end where directors are placed.

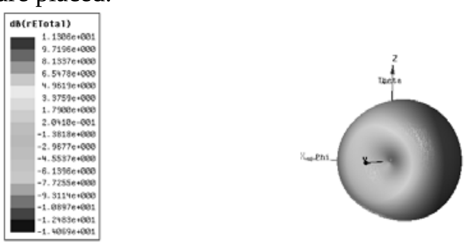

Fig 6. Radiation Pattern

### 3.6 Gain

Gain of the antenna in the desired frequency and in desired direction is flat as shown in Fig 7. Average gain is about 5 dB with maximum gain of 6.7 dB.

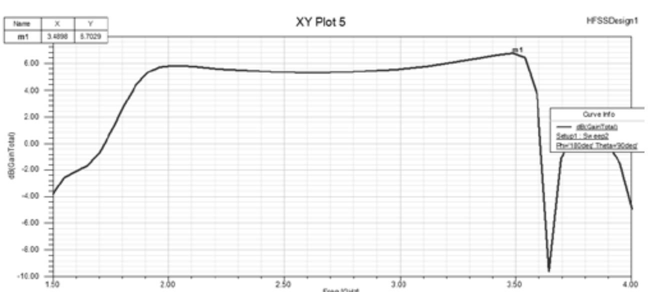


Fig 7. Gain

## 4. Comparative Analysis

The table below shows the comparison of the base work and the proposed work. Clearly there are improvements in impedance matching with coaxial line, return loss is improved drastically, antenna has started working in two bands and VSWR has reached very close to 1. Dual band operation came at the cost of the bandwidth but covering the two ISM band is more useful than getting a good bandwidth at only one frequency.

Table 1: Comparison with base paper

| ***Parameters*** | ***Proposed work*** | ***Base paper [1]*** |
|---|---|---|
| ***Frequency of operation*** | 2.65GHz and 4.98GHz | 2.76GHz |
| ***Bandwidth*** | 960 MHz & 456 MHz | 1 GHz |
| ***VSWR*** | ~1 | 5.1 |
| ***Input impedance*** | 44.32*Ω* at 4.98GHz<br>52.25*Ω* at 2.65GHz | 89.8*Ω* |
| ***Return loss*** | At 4.98GHz=-22.95dB<br>2.65GHz=-27.92dB | -11.11dB |

## 5. Conclusions

A bi-planar quasi Yagi antenna is designed to radiate in the WiFi and WiMax frequencies. The development started with the design of a bi-planar dipole. To increase its bandwidth and to make it directive a reflector and two directors are incorporated. Further in an attempt to increase its bandwidth performance Microstrip feed is enhanced to an inset feed, after which significant improvements over the referred work [1] has started appearing. With similar gain of 5dB as compared to [1] our antenna works between 2.17 GHz to 3.13 GHz and 4.8 GHz to 5.2 GHz.

## References

[1] J.Floc'h and A.Ahmad, "Broadband Quasi-Yagi Antenna for WiFi & WiMax Application" *Wireless Engineering and Technology*, Vol.4 No.2, 2013, pp.87-91.

[2] Z. Wang, X. L. Liu, Y.-Z. Yin, J. H. Wang, and Z. Li, "A novel design of folded dipole for broadband printed yagi-uda antenna," *Progress In Electromagnetics Research C,* Vol. 46, 23-30, 2014.

[3] S. X. Ta, H. Choo, and I. Park, "Wideband double-dipole yagi-uda antenna fed by a microstrip-slot coplanar stripline transition," *Progress In Electromagnetics Research B*, Vol. 44, 71-87, 2012.

[4] S. Lin, G.-L. Huang, R.-N. Cai, and J.-X. Wang, "Novel printed yagi-uda antenna with highgain and broadband," *Progress In Electromagnetics Research Letters*, Vol. 20, 107-117, 2011.

[5] Cai Run-Nan, Yang Ming-Chuan, Lin Shu, Zhang Xing-Qi, Zhang Xin-Yue, and Liu Xiao-Feng, "Design and Analysis of Printed Yagi-Uda Antenna and Two-Element Array for WLAN Applications," *International Journal of Antennas and Propagation*, vol. 2012, Article ID 651789, 8 pages, 2012

[6] Song, H.J.; Bialkowski, M.E.; Kabacik, P., "Parameter study of a broadband uniplanar quasi-Yagi antenna," in *Microwaves, Radar and Wireless Communications. 2000. MIKON-2000. 13th International Conference on* , vol.1, no., pp.166-169 vol.1, 2000

[7] Kumar, K. Prabhu et al. "Uni Planar Quasi Yagi Antenna for Channel Measurements at X-Band" *Journal of Theoretical and Applied Information Technology*, Volume 25, No. 2, 30th April 2011.

[8] Aghwariya M.K. "Microstrip Patch Yagi-Uda Array for Millimeter Wave Applications", *International Journal of Engineering Research and General Science* Volume 2, Issue 4, June-July, 2014

[9] Yagi, Hidetsu; Uda, Shintaro (February 1926). "Projector of the Sharpest Beam of Electric Waves". *Proc. of the Imperial Academy of Japan* pp. 49–52. Retrieved September 11, 2014.

[10] Y. Qian, W. R. Deal, N. Kaneda, and T. Itoh, "Microstrip-fed quasi-Yagi antenna with broadband characteristics", *Electronic Letters*, vol. 34, no. 23, pp. 2194–2196, 1998.

[11] L. I. Basilio, M. A. Khayat, J. T. Williams and S. A. Long, "The Dependence of the Input Impedance on Feed Position of Probe and Microstrip Line-fed Patch Antennas," IEEE Trans. Antennas and Propagation, Vol. AP-49, pp. 45-47, Jan. 2001.