# Comparison of Two designs of Inverted F antenna in n78 band

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**Short Report**

**Keywords:** 5G, PIFA, Inverted F, Substrate, Antenna, N78 Band

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# Comparison of Two Designs of Inverted F Antenna in n78 Band

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***Abstract*—** This paper consists of comparison of design of two inverted F shape antennas in n78 band (3500 MHz). The antennas shown in this paper have rectangular ground plate. First design has a conducting surface over ground plate which has an inverted F shaped strip in the same plane. The other design of antenna which is considered here has vertical shorting strip placed on it, which again has a rectangular plate perpendicular to it. Considering different parameters like radiation pattern, gain, VSWR and reflection coefficient here we will see the best results of both the antennas in n78 band and talk about the design which can be used in most of our applications.

***Keywords*— *5G, PIFA, Inverted F, Substrate, Antenna, N78 Band***

## 1. Introduction

It is strongly believed that using of 5G services will just improve the speed of internet, but there are many more perks of shifting to 5G. Few of them include the number of bands allowed in 5G which results into improvement of bandwidth. With that having 5G network will also reduce the latency as well as make our communication faster with cloud services. As mentioned earlier there are many bands available in 5G, however here the designs which are shown are made to work in n78 band of the 5G service.

There are many antennas which are designed to work in different frequency range and are mainly used in mobiles and laptops, Inverted F is one of it. The major advantage of Inverted F over other designs is it's high gain, small size, good radiation pattern, less weight, less cost and many more. However, it can only be used in narrow bandwidth. To overcome this disadvantage there are many designs of Inverted F antenna made [1] [2] [3] [4] [5] [6]. Referring to those designs here you will see 2 designs of Inverted F antenna using appropriate dimensions which will give us the best results in n78 band.

There are many bands present in 5G, out of which n78 is one of the popular bands. The n78 band's popularity is due to its relatively common availability, compared to lower cellular spectrum. This band is historically used in small WiMax and P2mP wireless network. The major disadvantage of this band is the limited range and less building penetration. However, these disadvantages are removed by using advance processing techniques such as beam forming.

In this work a comparative study of 2 mostly used designs of Inverted F antenna is done by simulating using Altair Cadfeko [7] and studying it accordingly

## 2. Antenna Geometry Layout and Design

### A. Design 1

Figure 1 describes schematic of the simplified geometry of 1st design i.e Inverted F Antenna in Altair Feko. Figure 1a illustrates the top view of the Antenna whereas Figure 1b shows the side view of the Antenna. Figure 1c represents the side view of the Antenna.

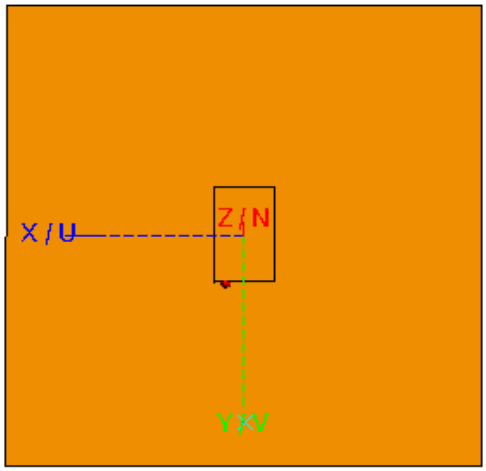


Fig 1a Top View

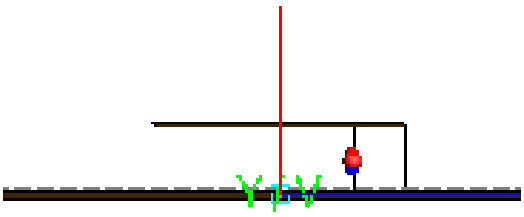


Fig 1b Side View

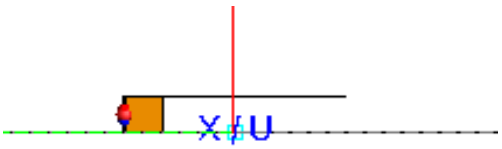


Fig 1c Front View

### B. Design 2

Figure 2 describes schematic of the simplified geometry of 2nd design i.e Inverted F Antenna in Altair Feko. Figure 2a illustrates the top view of the Antenna whereas Figure 2b shows the bottom view of the Antenna. Here the blue plate which we can see is the substrate with permittivity 3.55

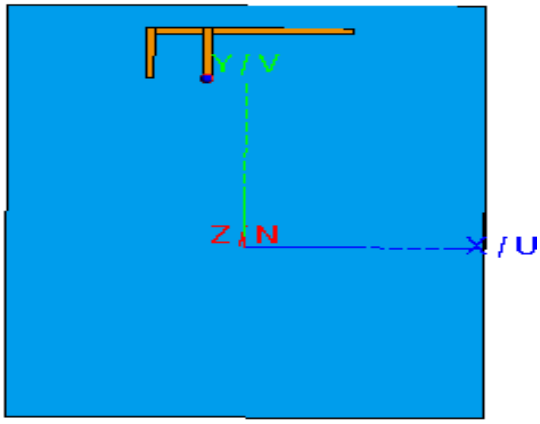


Fig 2a Top view

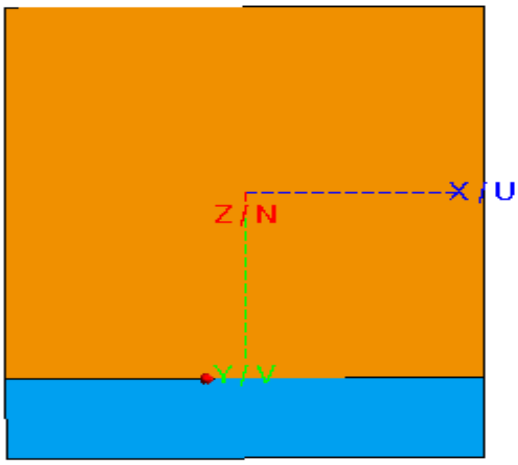


Fig 2b Bottom View

## I. SIMULATED RESULTS ANALYSIS AND DISCUSSION

### *1. Design 1*

*A. Reflection Coefficient(dB) Characteristics curve*

A simulated reflection coefficient $S_{11}$ (dB) versus frequency (GHz) characteristics curve is depicted in Fig. 3.1

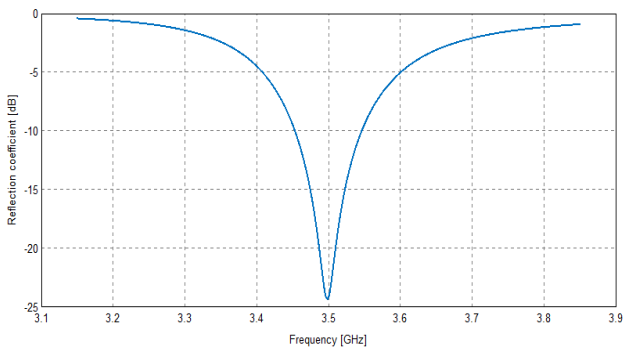


Fig 3 Simulated $S_{11}$ (dB) of design 1

It is clear from the above figure that the reflection coefficient for this design is less than -8dB only for the bandwidth of 100MHz (3.45GHz – 3.55GHz) which covers 20% of the n78 Band

*B. Three-Dimensional Radiation characteristics and gain of Proposed Antenna:*

To know how efficiently the proposed antenna is able to convert electrical signals into free space signals and vice versa, the simulated 3-dimensional (3D) far field radiation patterns at 3.4GHz, 3.5GHz and 3.6GHz demonstrated in Figure 4a, 4b and 4c, respectively.

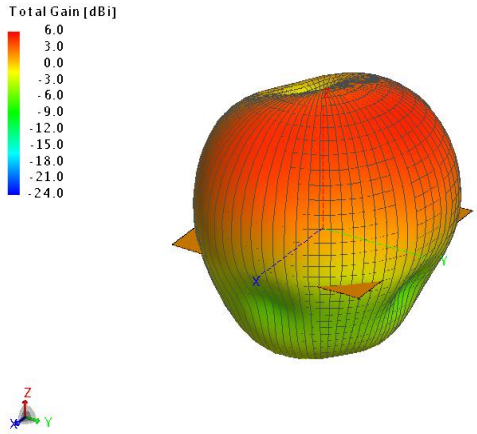


Fig 4a at 3.4 GHz

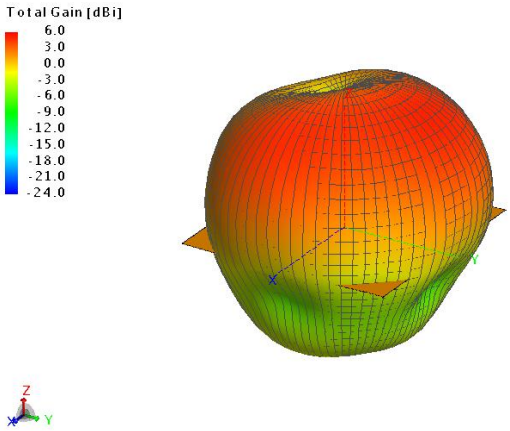


Fig 4b at 3.5 GHz

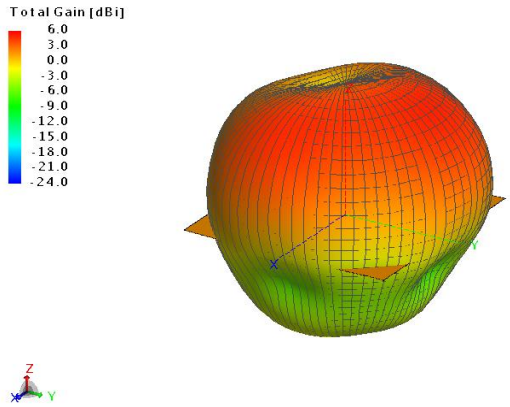


Fig 4c at 3.6 GHz

Above radiation pattern clearly tells that design 1 of Inverted F antenna has omnidirectional radiation pattern. Also the total gain in the desired frequency follows the 3 dB rule which makes this design, a suitable candidate for frequency between 3.45 GHz to 3.55 GHz.

## 2. *Design 2*

### *A. Reflection Coefficient(dB) Characteristics curve*

A simulated reflection coefficient $S_{11}$ (dB) versus frequency (GHz) characteristics curve is depicted in Fig. 5.1

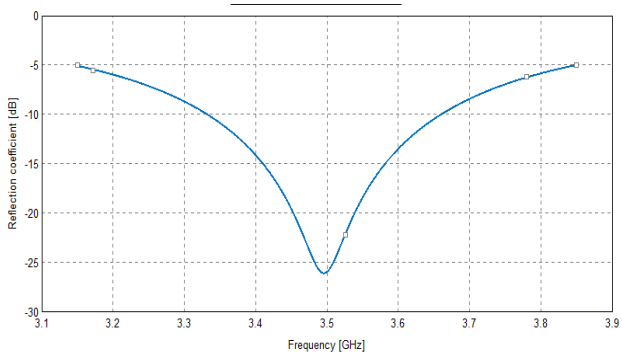


Fig 5 Simulated $S_{11}$ (dB) of design 1

It is clear from the above figure that the reflection coefficient for this design is less than -8dB for the bandwidth of 400MHz (3.3GHz – 3.7GHz) which covers 80% of the n78 band leaving just 100MHz at the end

### *B. Three-Dimensional Radiation characteristics and gain of Proposed Antenna*

Although, s11 operates well in this frequency range, its also equally important to have proper radiation pattern in n78 band. Therefore, the simulated 3-dimensional (3D) far field radiation patterns at 3.3GHz 3.4GHz, 3.5GHz, 3.6GHz and 3.7GHz demonstrated in Figure 6a, 6b, 6c, 6d and 6e respectively.

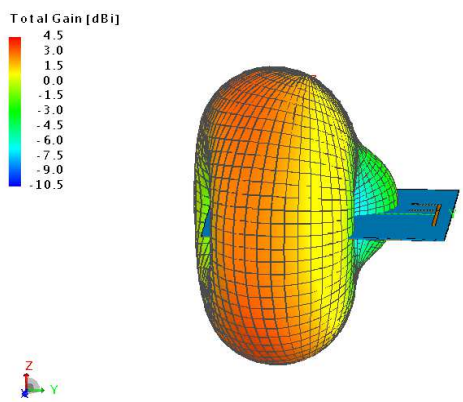


Fig 6a at 3.3 GHz

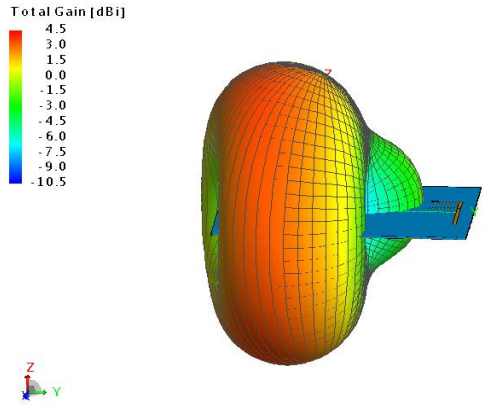


Fig 6b at 3.4 GHz

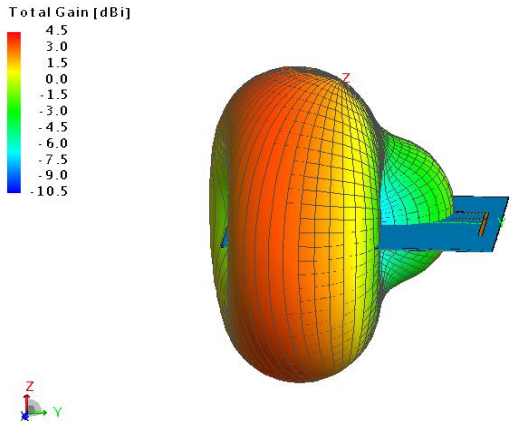


Fig 6c at 3.5 GHz

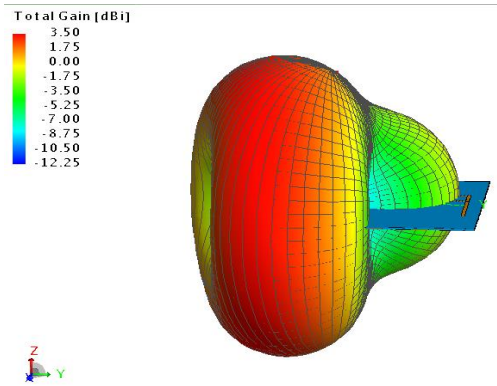


Fig 6d at 3.6 GHz

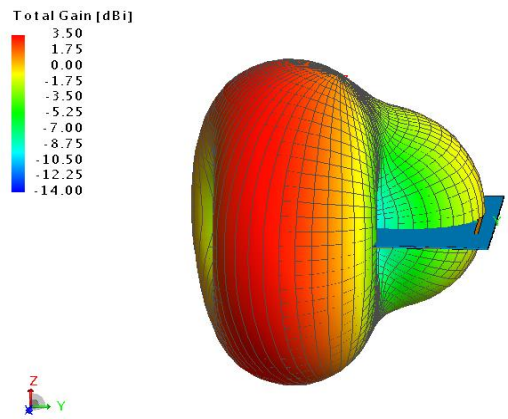


Fig 6e at 3.7 GHz

From given radiation pattern we can clearly see that antenna emits isotopically. However, the gain in this case follows 3dB rule which allows us to use this design in suitable applications.

## II. Discussion and Conclusion

After looking into both the designs and its results, we can say that design 2 has wider bandwidth compared to design 1. However, one of the most important drawback of design 2 over design 1 is its isotropic radiation pattern which stops us from using it in most of the applications.

So it is recommended to know about application, before deciding the type of antenna to be used. If it's fine to have narrow bandwidth, then it's important to use design 1 due to its omnidirectional radiation pattern and the gain associated with it. However, if its important to have wider bandwidth, then we need to use 2nd design considering its low gain and isotropic radiation pattern.

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## Data Availability Statement

All data generated and analyzed during this study is included in this published article.

## Declaration


1. Funding: No funding was required for this research work.
2. Conflict of Interest: Author declares that there was conflict of interest while doing this study.
3. Availability of Data: All the data generated and used for analysis is provided in this manuscript.
4. Code and Software Availability: All the simulation in this study were done using student version of software named ALTAIR Feko.
5. Authors Contribution: Complete study and manuscript preparation was done by Sarvesh Gharat.