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# Experimental Investigation of Spiral UWB Antenna using IE3D Tool

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## Abstract

The demand for antennas has led to the creation of a large number of antennas. It was Heinrich Hertz's development of the dipole antenna that laid the foundation for today's communication technologies. Broadband antennas that are small in size yet offer more coverage and are very profitable are now required. The lumped circuit is automatically extracted from IE3Dsimulation and optimised for IE3D in this study. With its functions, IE3D is extremely beneficial to RFIC developers.

**Key words:** *IE3Dsimulation, RFIC, dipole antenna, Broadband antennas*

## Introduction

When compared to conventional methods, there are numerous advantages to using UWB technology. For example, there is no radio frequency. Instead, timed bursts of electromagnetic radiation are emitted by UWB. This means that the transmitter and receiver components needed for mobile devices can be easily manufactured. There are several components to the Unified Wireless Broadcasting (UWB) technology stack. There are a slew of options for mobile applications. An antenna with sufficient wireless bandwidth and satellite communication is described in this article.

Interference from and from other narrow-band methods can be eliminated using UWB. The UWB signal can be layered on top of the present frequency in various narrowband schemes, allowing for efficient utilisation of the frequency. In spite of its primary focus on terrestrial short-distance communication, the UWB has the potential to be sent from space via a satellite (referred to as "Satellite UWB") to the ground. The introduction of a new channel in satellite communications does not need the allocation of new frequencies in present satellite services that overlap with the UWB signal on an existing frequency band. This technique is used by some UWB devices that feature simple transmitter and receiver setups.

For the terrestrial UWB system, mass production would result in low-cost appliances. The UWB satellite terminal can be less expensive because the same system can be used to communicate via satellite with UWB terrestrial equipment. The UWB signal can be layered on top of the current narrowband spectrum. This will improve satellite technology's spectrum efficiency.

### Need and Significance of the work

In the short list of antenna types that are UWB simultaneous, circularly polarised, and machine-manufacturable in a microstrip context, spirals are especially valuable because of their frequency-independent (FI) features.

Devices with amplitude and comparison methods can be found using spiral antennas. In order for a manoeuvring aircraft to be ready to respond to any particular danger signal orientation, circular polarisation is an important feature for directions. Rather than using any polarisation, hazard signals are typically linearly polarised radiators.

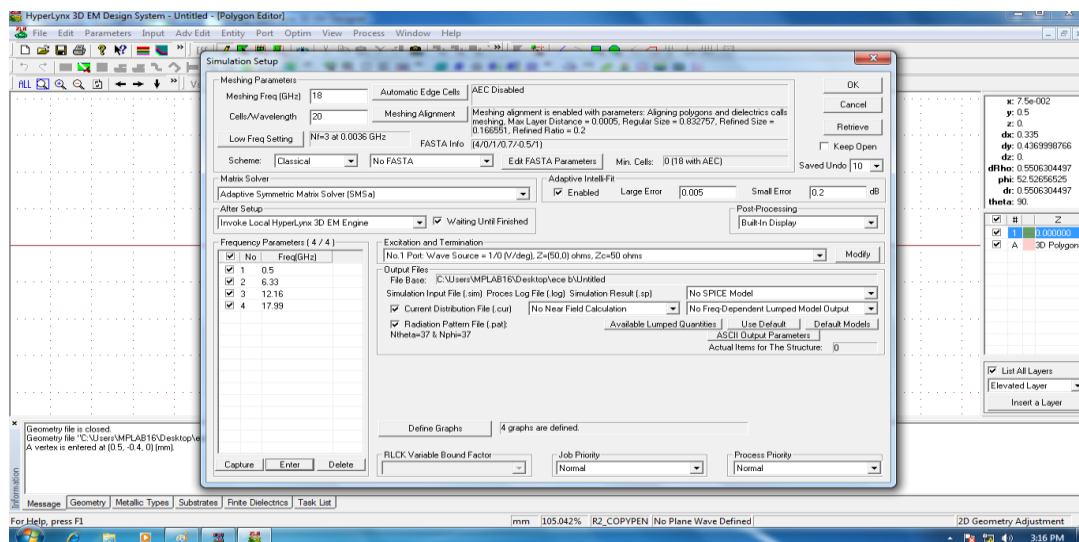
Numerous applications, from military surveillance to ECM and ECCM to numerous commercial and private sector applications such as a variety of LPD antennas on transport vehicles are possible with spiral antennas due to their ability to maintain coherent gain and input impedance over wide bandwidths. An ideal bandwidth of 100:1 is required for high-gain antennas that can be mounted on vehicles on land, air, or sea, with frequencies ranging from 0.5 to 18 GHz. Army and economic interests in particular have a substantial presence.

## Research Methodology

**Simulation Process and Results For Circular Spiral Antenna:** After declaring the ports again go to port option and click exit port option and then save the geometry. For finding out the different antenna parameters we have to follow the following the steps:

### STEP 1:

Choose Process->Command Simulation. This dialog opens the Simulation Configuration dialog ( Figure 1). Our structure would be simulated at 4 frequency points from 0.5 to 18 GHz. In the Frequency Parameters dialog, select the Enter key. The frequency spectrum is prompted by MGRID. Enter Free start= 0.5, Free end= 18, Free number= 4. To attach frequency settings to the list box, select OK. To show the s-parameters usually, we don't need to use MODUA. We will use the embedded MGRID display. Choose the key Defining Graphs (Figure 1). The "S-Parameters and Frequency..." dialog is established. Choose the key Add Graph. The graph type is requested. S-Parameters select. Select. You are encouraged to select the graph for display. Choose dB[S (1, 1)]. Select OK. Go back to the Simulation Configuration dialog. Next to the "Defining Graphs" key you will see "Graphs are described." Our intention is to safely visualize the s-parameter using the graphs in advance. To go ahead, select OK. MGRID invokes IE3D to carry out the background simulation. It requires seconds to complete. IE3D creates graphs for the s-parameter dB plot after simulation.



**Fig 1: Simulation setup**

### STEP 2:

Click on "current distribution file" option and "radiation pattern file" option available in the window, a new window is displayed, just enter the elevation angle values as well as azimuth angle values for the purpose of radiation pattern display and then click OK to continue the process and previous window is displayed ,click OK.

### STEP 3:

Go to "window" option available at the top in the "polygon editor window". Just click on that, different options are available as shown in fig 2 .We have to select our required parameters.

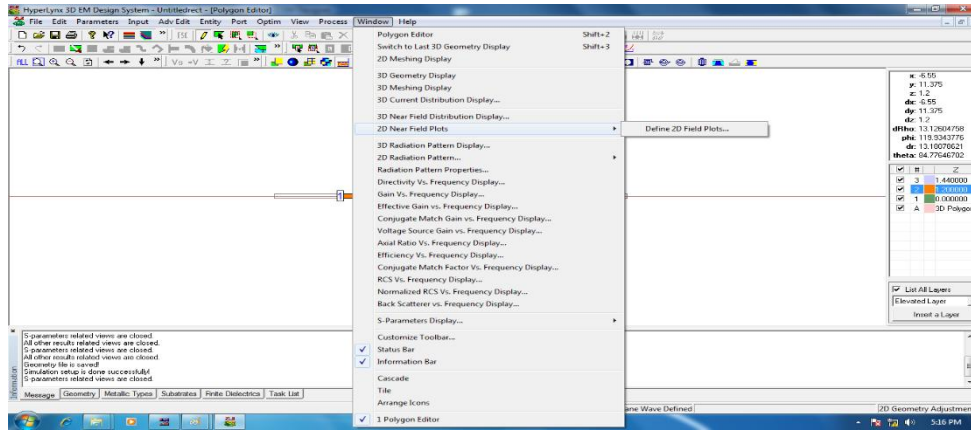


Fig 2: Polygon editor window

**STEP 4:**

From the available options click on “3D current distribution “to know current flow of an antenna, which is shown in the fig 3.

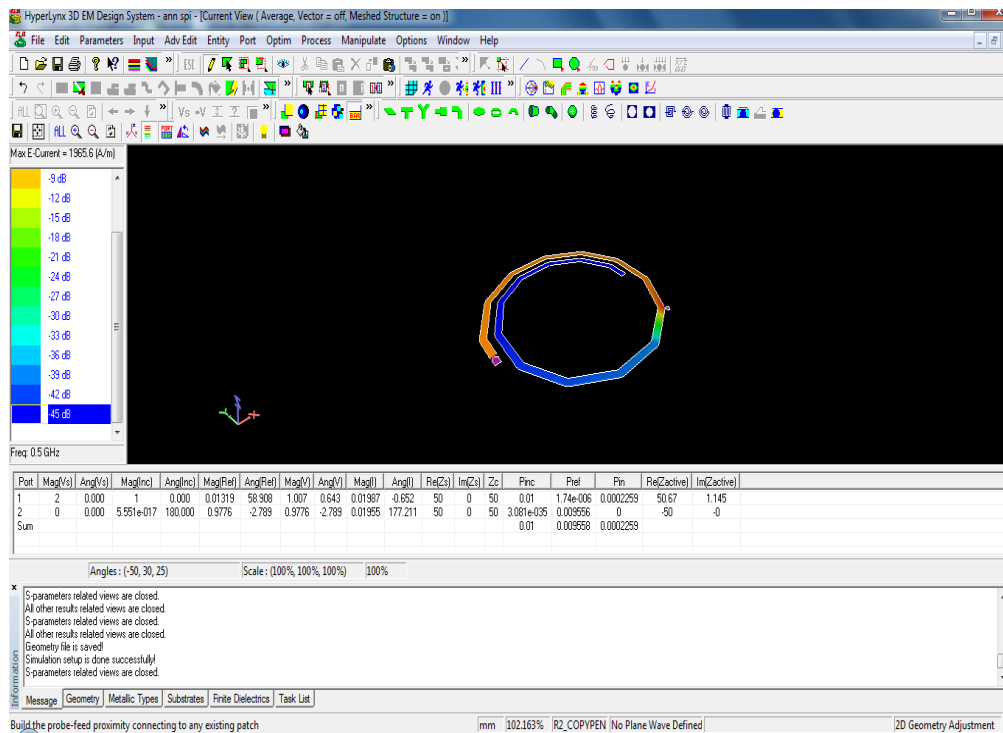


Fig 3: Current distribution window

**STEP 5:**

From the available options click on” 3D radiation pattern” parameter.3D radiation pattern of circular spiral antenna is displayed and as shown in the fig 4.

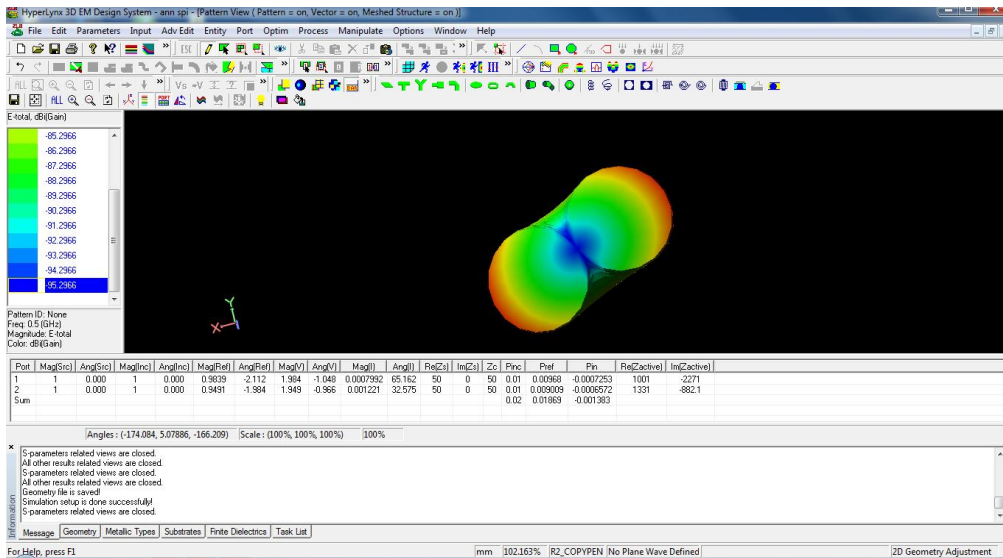


Fig 4: 3D radiation pattern window

**STEP 6:**

From the available options click on 2D radiation pattern. 2D radiation pattern window is displayed as shown in fig 5. In that window select the required elevation and azimuth angle values. After selecting required values click ok to continue. Then 2D radiation pattern graph is displayed as shown in fig 6. In that graph PG represents the power gain of an antenna, AG represents the antenna gain. Expressions for this PG, AG is given as

$$PG = (\text{Directivity}) * (\text{antenna efficiency})$$

$$AG = K * (\text{Directivity}) \quad (K = \text{reference value})$$

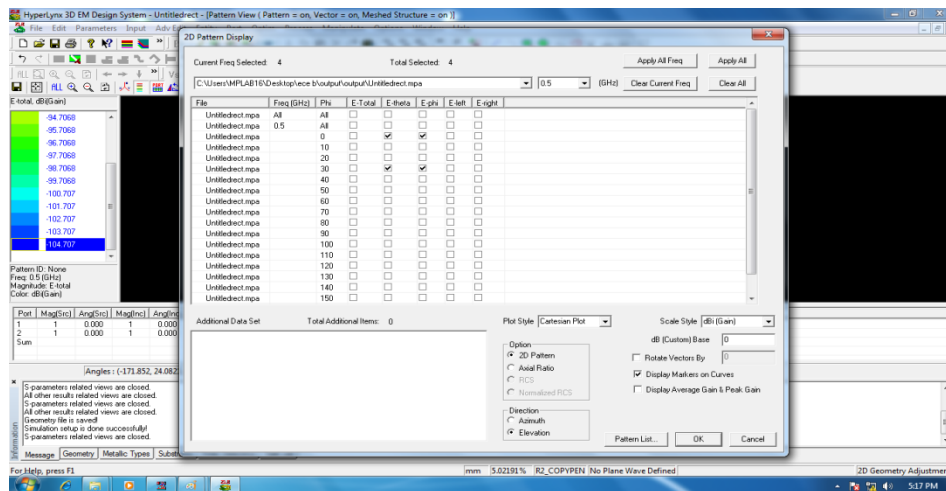


Fig 5: 2D pattern display window

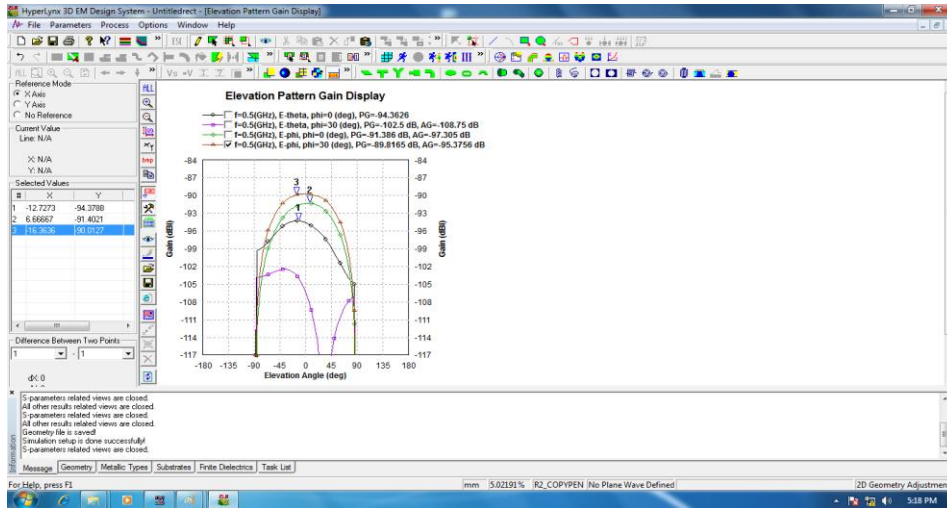


Fig 6: Elevation pattern Vs. Gain Display

**STEP7:**

Go to step 3 and click on “Directivity vs. Frequency” display option and then “a new window “is displayed for selecting the required elevation angle and azimuth angle values .After that click on OK .Directivity vs. Frequency graph window is displayed as shown in fig 7.

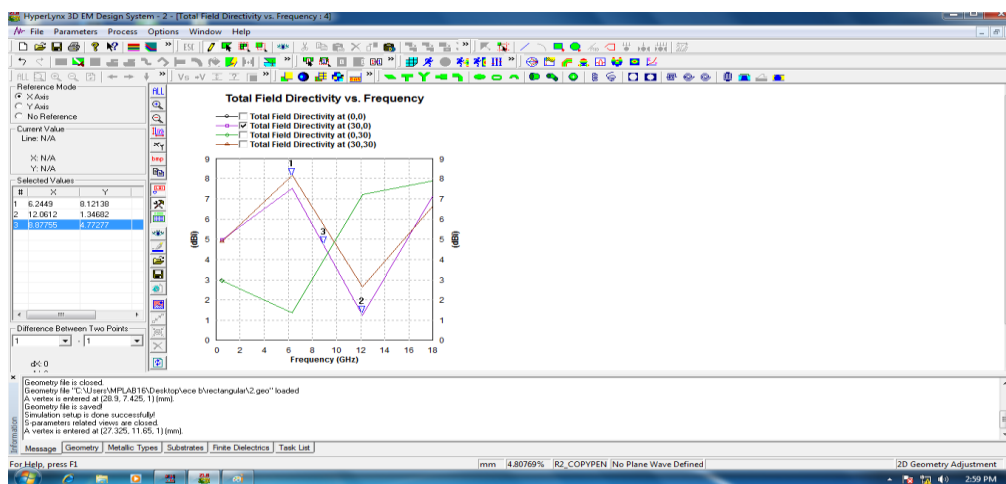


Fig 7: Directivity vs. Frequency display window

**STEP 8:**

Go to step 3 and click on Gain vs. Frequency display option and then a new window is displayed for selecting the required elevation angle and azimuth angle values .After that click on Ok .Gain vs. Frequency graph window is displayed as shown in fig 8

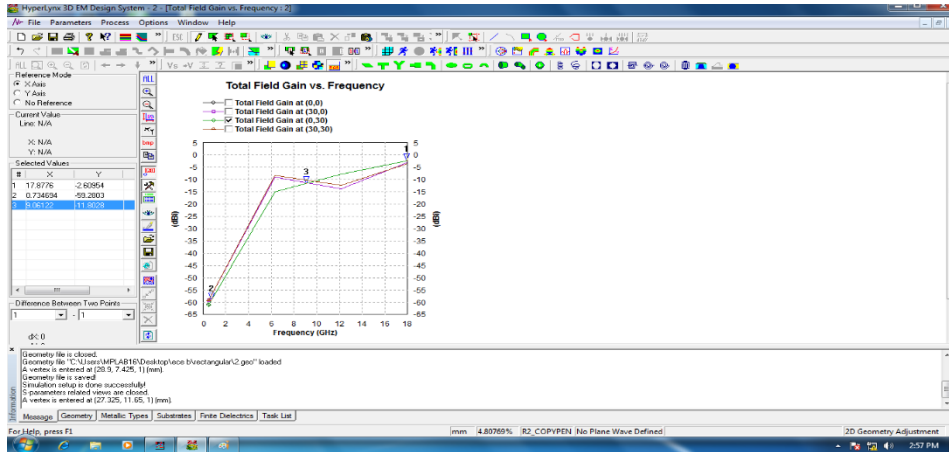
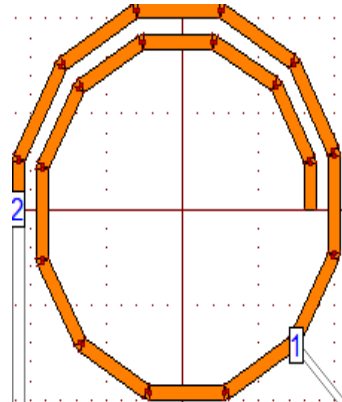
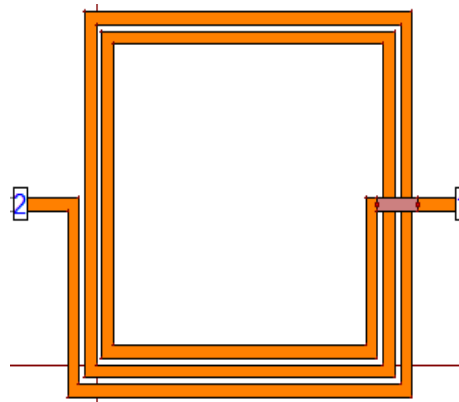


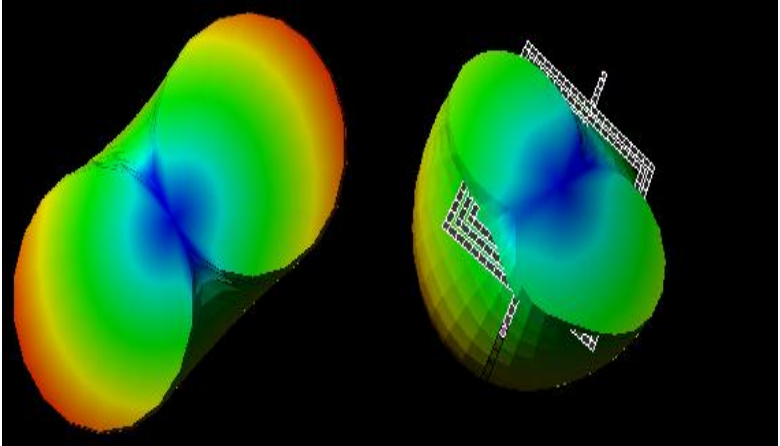
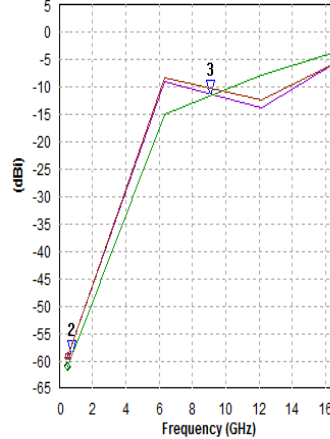
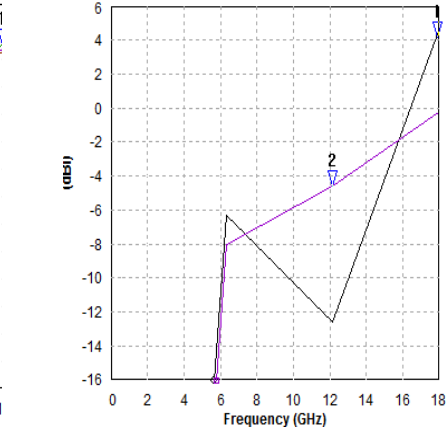
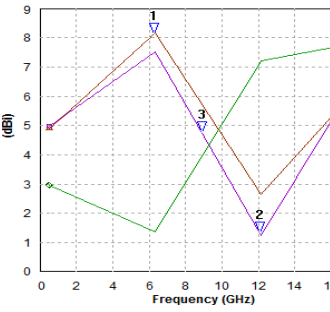
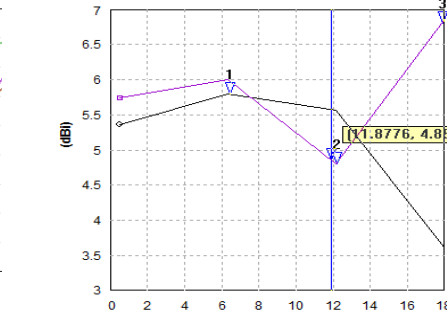
Fig 8: Gain vs Frequency display window

## Results and Discussion

To get an idea of performance of each antenna, we can look at the data in the following table 1. The rectangular spiral antenna has a higher gain value than the circular spiral antenna, based on the comparison of their gain values. This is because bandwidth has a negative relationship with gain. The high bandwidth is due to the low gain value.

Table 1: Comparison between rectangular and circular spiral antenna

Parameters	Circular spiral antenna	Rectangular spiral antenna
Frequency range	(0.5 – 18 )GHZ	(0.5 – 18 )GHZ
Structure		

<p><b>3DRadiation pattern</b></p>		
<p><b>Parameters</b></p>	<p><b>Circular spiral antenna</b></p>	<p><b>Rectangular spiral antenna</b></p>
<p><b>Gain vs Frequency graph</b></p>		
<p><b>Directivity v1s Frequency graph</b></p>		
<p><b>Gain</b></p>	<p>80.29dBi</p>	<p>58.31dBi</p>
<p><b>Beam width</b></p>	<p>(90.29,174.07)deg</p>	<p>(40,190)deg</p>
<p><b>Directivity</b></p>	<p>5.04dBi</p>	<p>5.77dBi</p>
<p><b>Radiated power</b></p>	<p>5.8096exp(011) W</p>	<p>7.8053exp(009) W</p>
<p><b>Radiating efficiency</b></p>	<p>4.465%</p>	<p>0.14264%</p>



## Conclusion

An excellent IE3D tool has been used to model and analyse spiral antenna design. The dielectric constant and substrate materials can also be varied to test this concept. Spiral antennas can be made physically with the help of a PCB circuit board thanks to this programme. This software allows for the creation of spiral antennas for a variety of frequencies. Based on the gain values of the antennas, we can see that the rectangular spiral antenna performs better than the circular spiral antenna.

Amplification's gain decreases linearly as bandwidth increases. Simulated data shows that spiral antennas are a common choice for satellite communication systems because of their small size, large bandwidth and good gain, even though rectangular spiral antennas are superior. This contained the recommended antenna's UWB standard BW. In addition, the antenna's emission pattern remained omnidirectional for the vast majority of the body. Because of the antenna's advantages, such as its adaptability, it worked for UWB applications.

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