

# CHARACTERIZATION OF ULTRA-WIDE BAND ANTENNAS WITH ADVANCE DESIGN SYSTEM (ADS) BY AGILENT

*This work has been performed by Master of Science Degree students in Circuits and Integrated Systems for Communications.*

## INTRODUCTION

The aim of this work is to demonstrate the capabilities of a bow-tie antenna to operate in ultra-wide band applications, by using ADS.

Let us consider a bow-tie antenna as in Fig. 1. In order to derive the characteristic impedance of hypothetical, infinite long bow-tie dipole one can imagine an equivalent biconical antenna, with the same total surface.

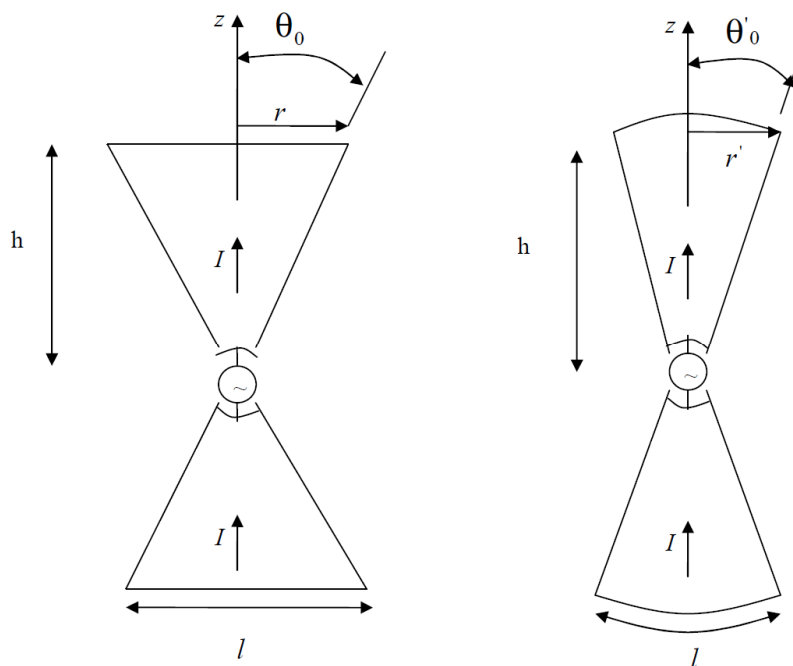


FIG.1 Biconical antenna equivalent to a bow-tie antenna

The characteristic impedance of the bow-tie antenna can be derived as:

$$Z_{C_{bow-tie}} = 120 \ln \cot \frac{\theta_0'}{2}$$

$$\cot \theta_0' = \frac{h}{r'}$$

As the triangle base is equal to half length of the cone base, then:

$$r' = \frac{l}{\pi}$$

Given that

$$\tan \theta_0' = \frac{2}{\pi} \tan \theta_0$$

one can obtain the characteristic impedance of a bow-tie dipole as:

$$Z_{C_{bow-tie}} = 120 \ln \cot \left[ \frac{1}{2} \arctan \left( \frac{2}{\pi} \tan \theta_0 \right) \right]$$

or, for a bow-tie monopole

$$Z_{C_{bow-tie}} = 60 \ln \cot \left[ \frac{1}{2} \arctan \left( \frac{2}{\pi} \tan \theta_0 \right) \right].$$

### **CHOICE OF ANTENNA SIZE FOR A FREQUENCY RANGE FROM 300 MHZ TO 3 GHZ**

For a characteristic impedance of  $50 \Omega$  an angle  $\theta = 60^\circ$  should be considered .

$$f_{\min} = 300 \text{ MHz}$$

$$\lambda_0 = \frac{300}{300} = 1 \text{ m} = 100 \text{ cm}$$

$$\lambda \sim \lambda_0$$

$$\lambda \cong \frac{\lambda_0}{1,25}$$

$$\lambda = \frac{100}{1,25} = 80 \text{ cm}$$

$$\frac{\lambda}{4} = 20 \text{ cm}$$

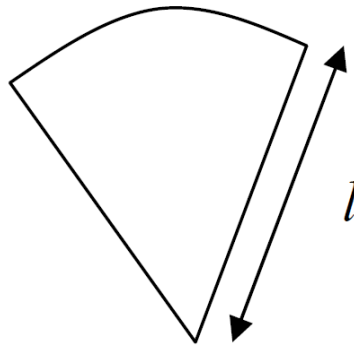


FIG.2 Choice of the length of radiators

## RESULTS. SIMULATION IN ADS

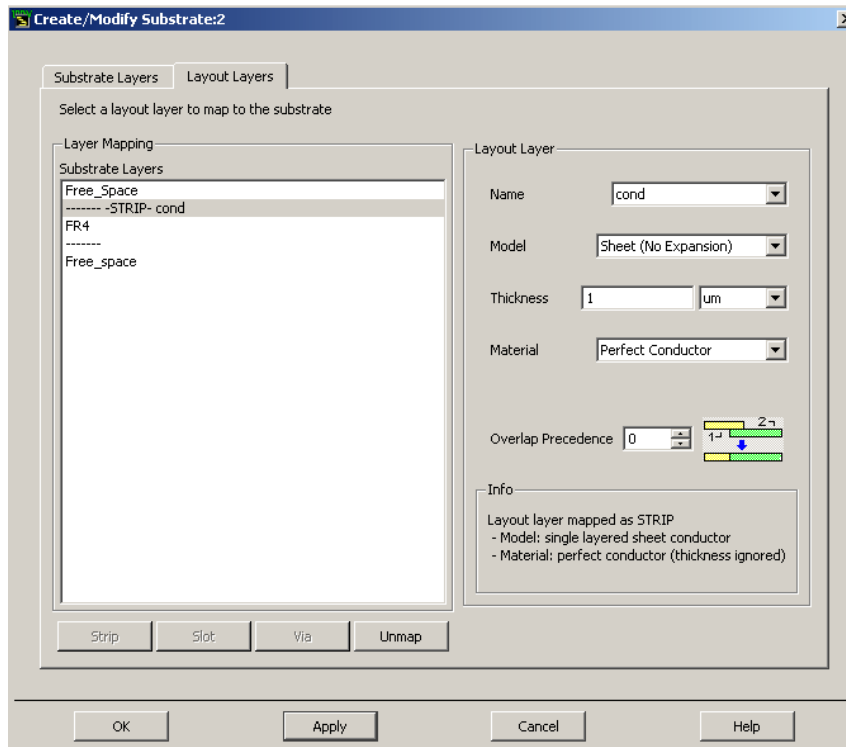
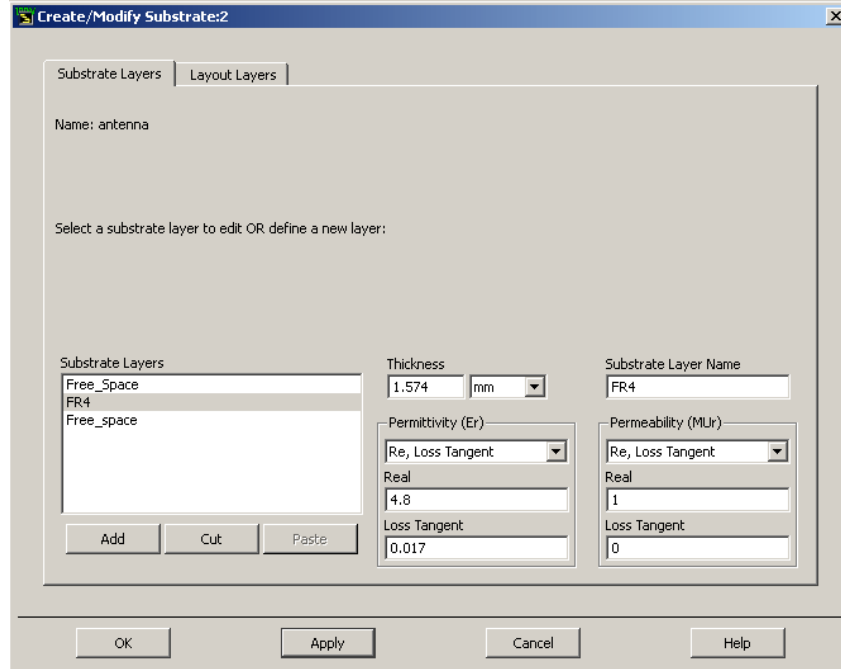


FIG.3 Substrate choice

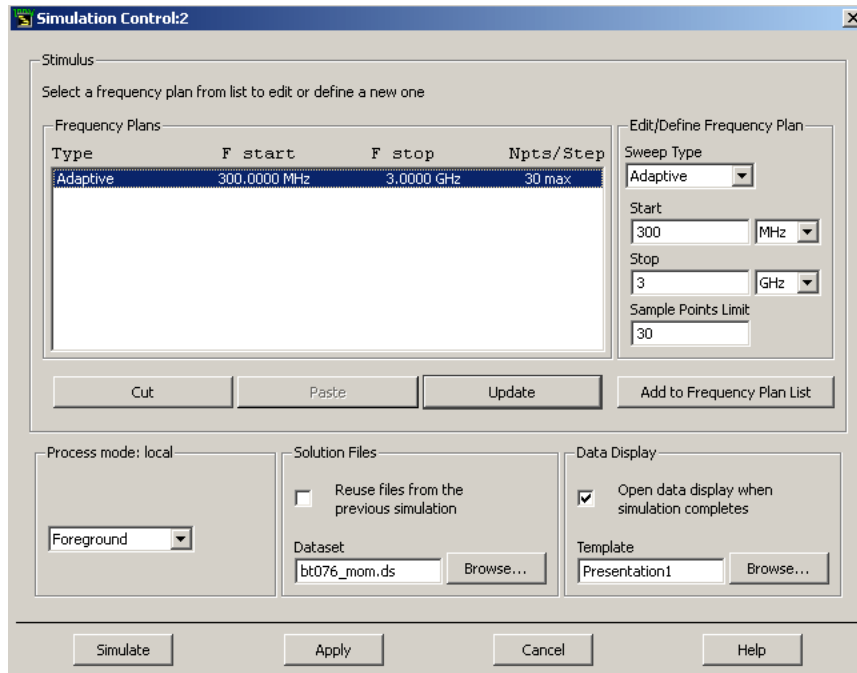


FIG.4 Stimulus setup

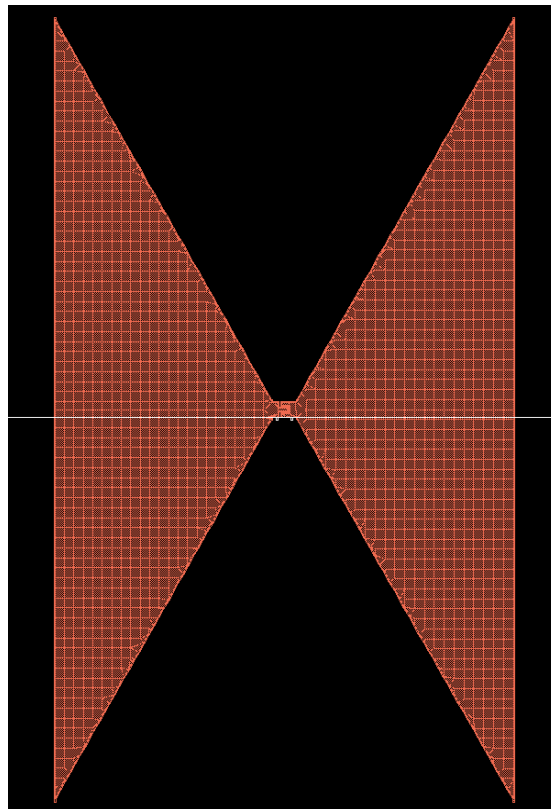


FIG.5 Bow-tie antenna layout in ADS

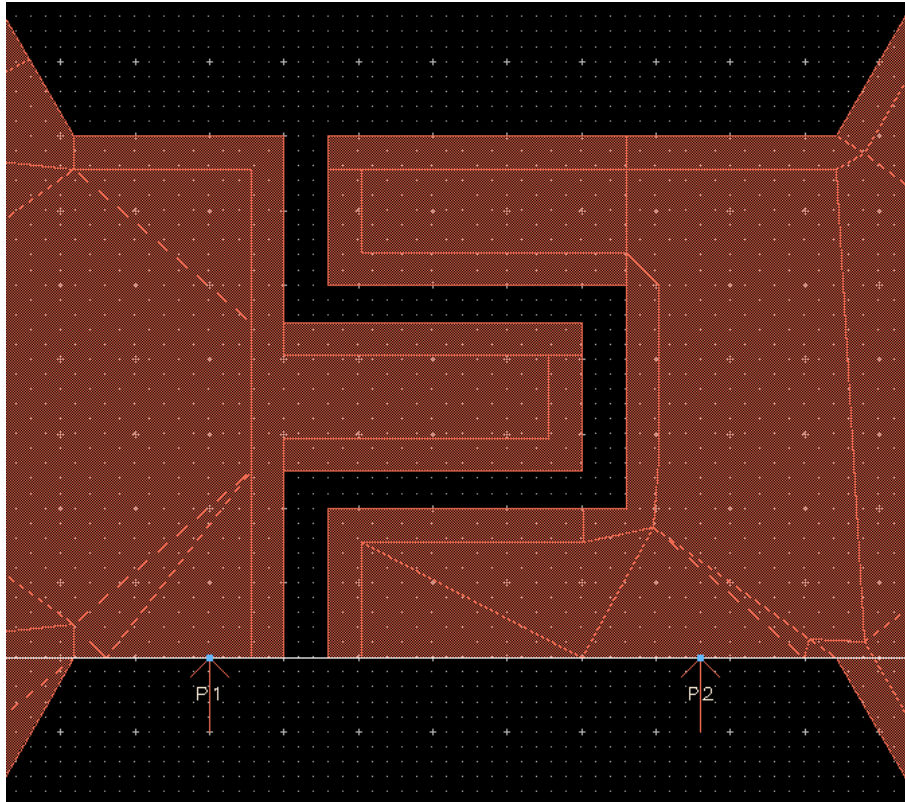


FIG.6 Excitation detail for a SMA connector

## Directivity and gain

Dataset: bt073\_f - Feb 16, 2011

Power

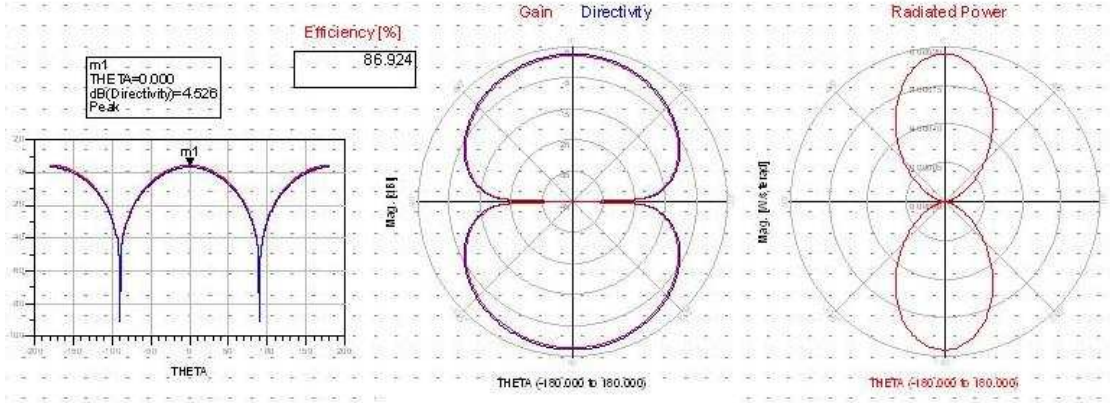


FIG.7 Polar diagram at 0.6 GHz

Dataset: bt073\_f - Feb 16, 2011

Power

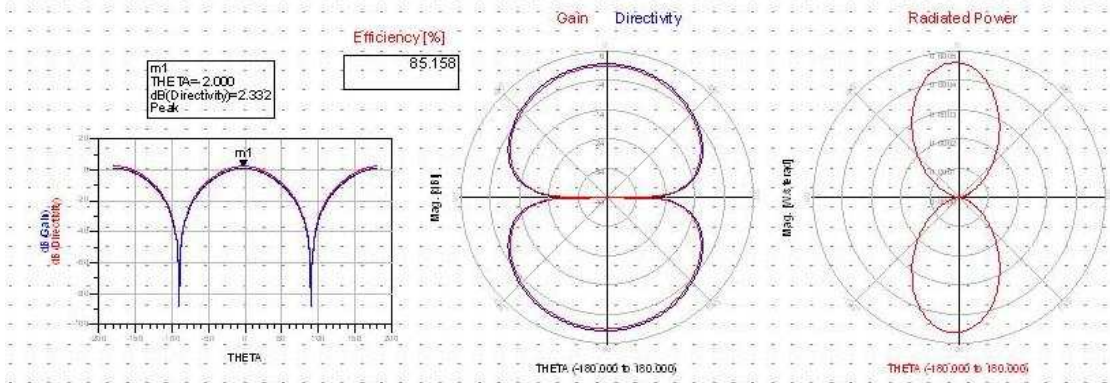


FIG.8 Polar diagram at 0.942 GHz

Dataset: bt073\_f - Feb 16, 2011

Power

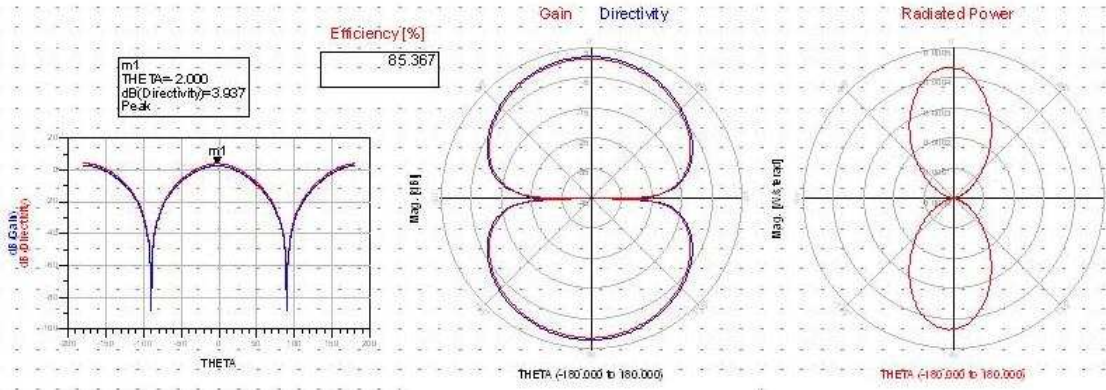


FIG.9 Polar diagram at 1 GHz

Dataset: bt073\_f - Feb 16, 2011

Power

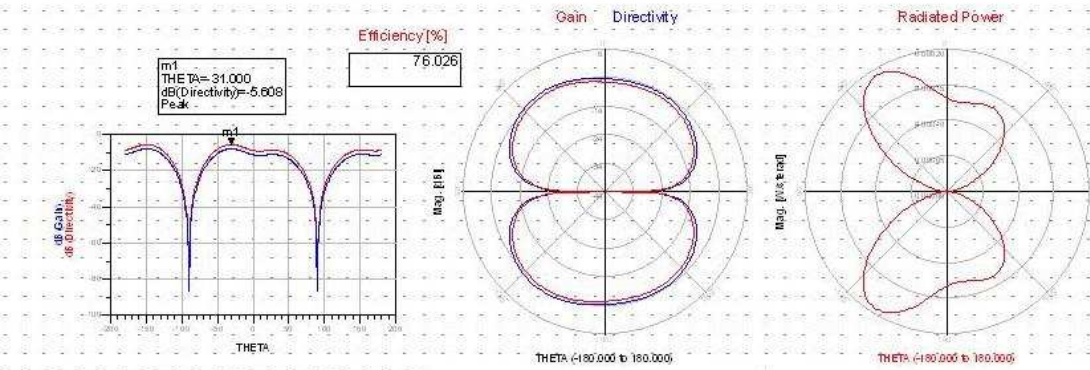


FIG.10 Polar diagram at 1.571 GHz

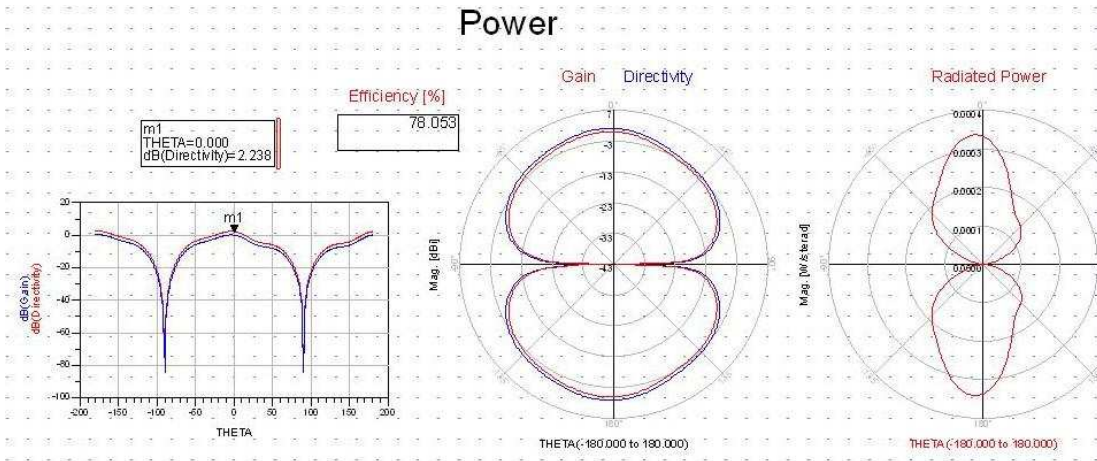


FIG.11 Polar diagram at 1.742 GHz

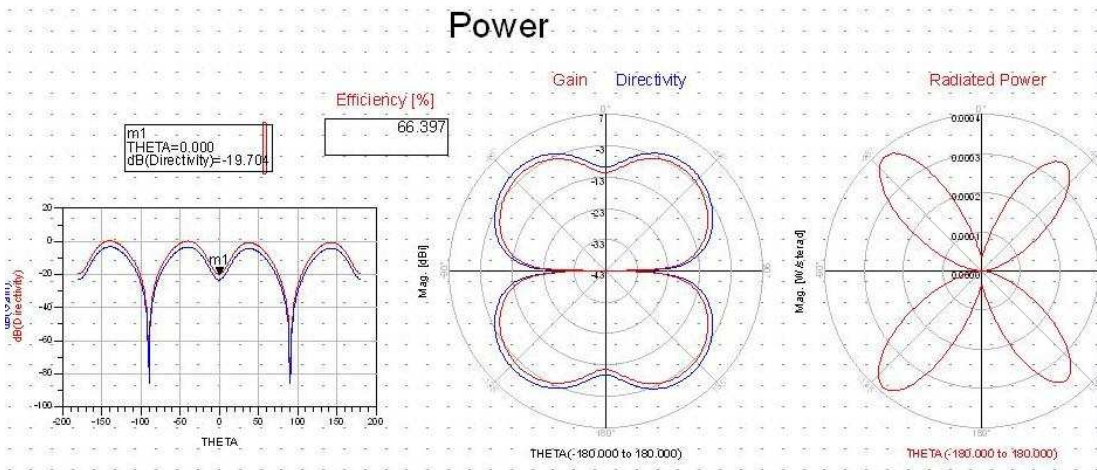


FIG.12 Polar diagram 2.314 GHz

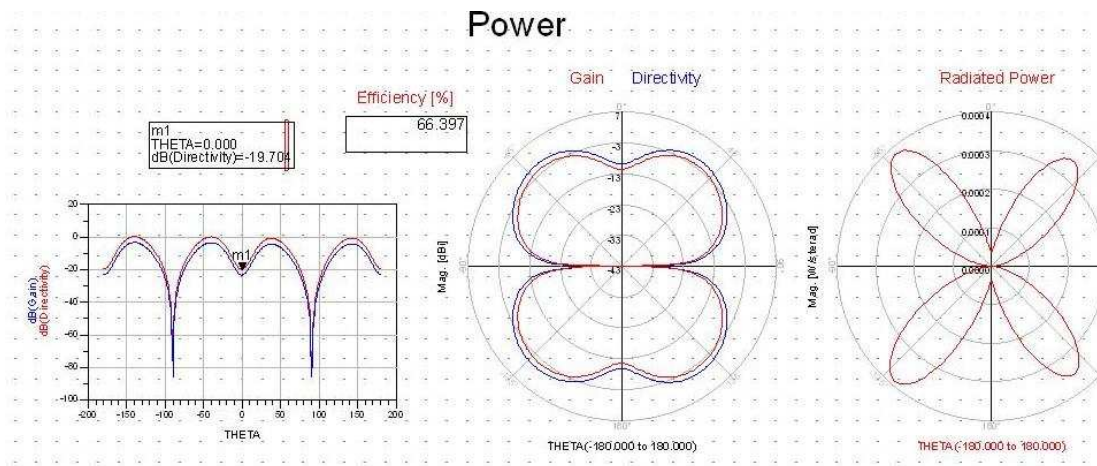


FIG.13 Polar diagram 2.542 Ghz

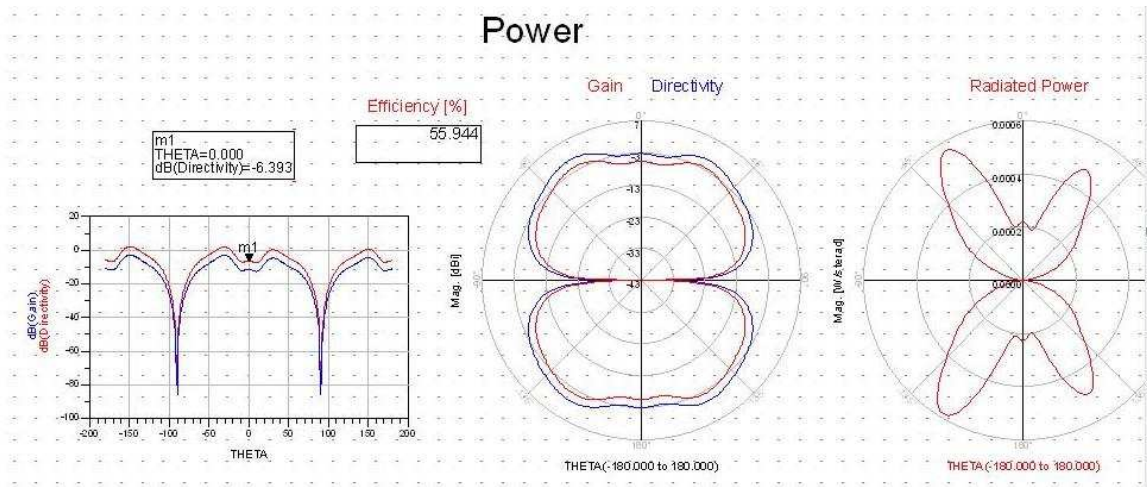


FIG.14 Polar diagram 3 GHz

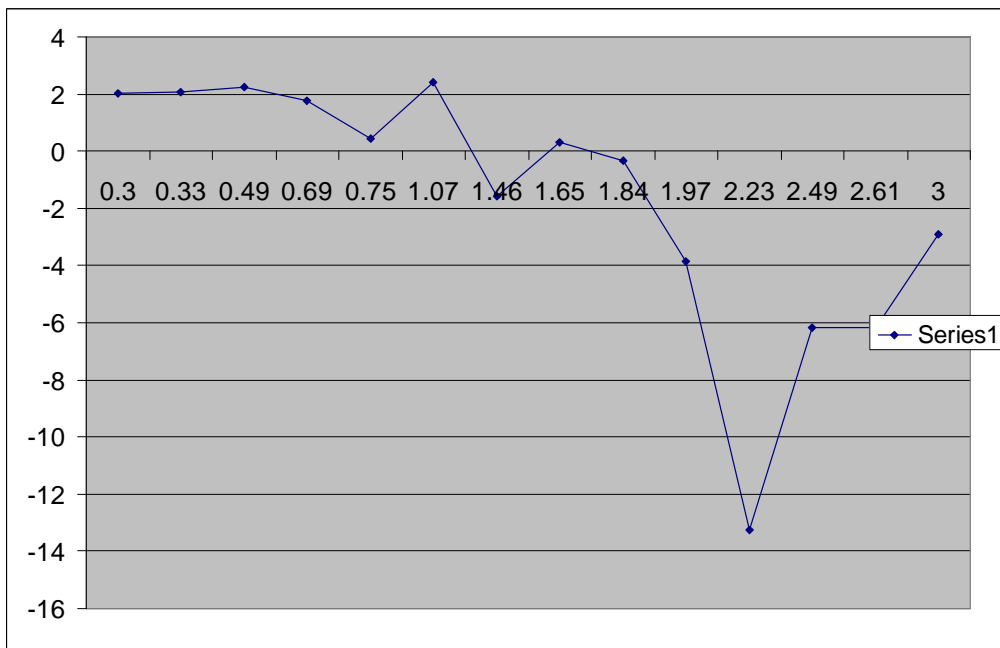


FIG.15 Gain variation: simulated

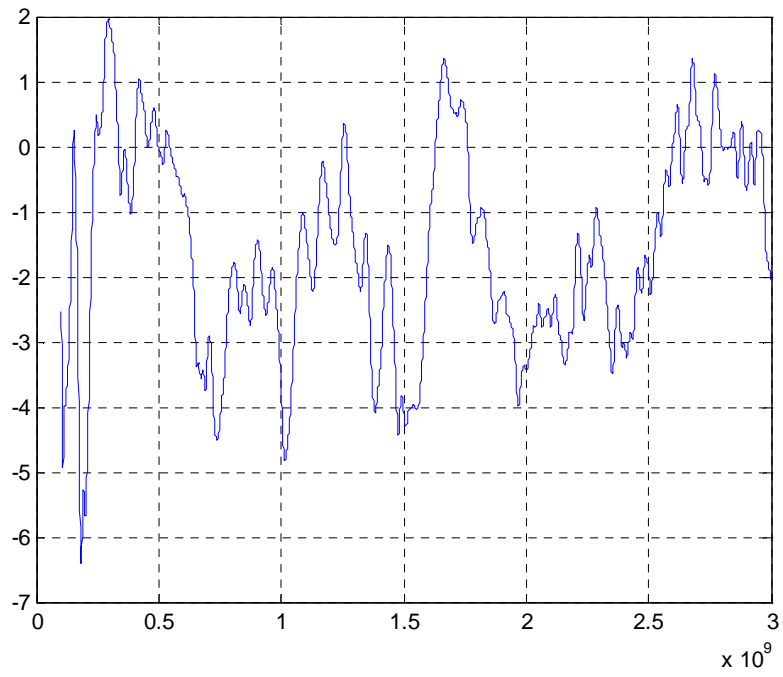


FIG.16 Gain variation: measured, by using the image method (non-anechoic environment, averaged data)

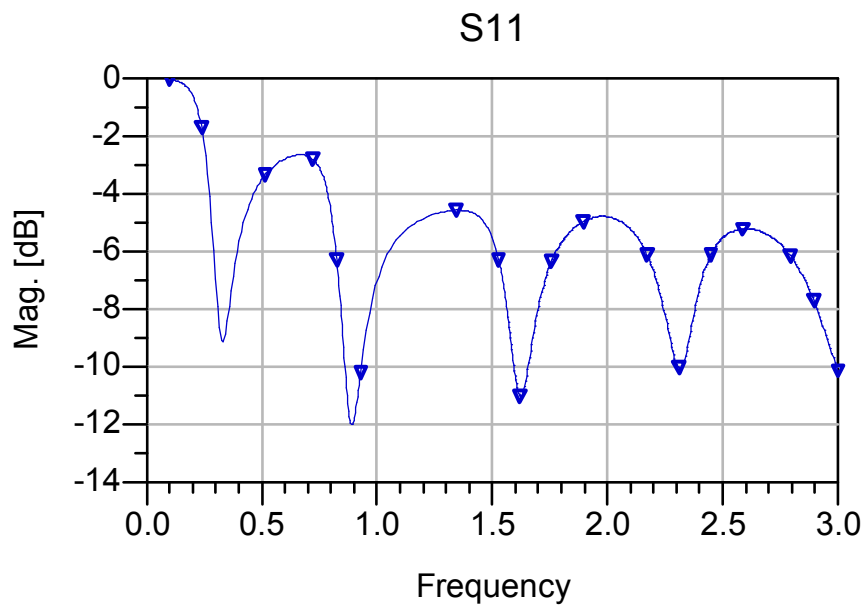


FIG.17 S11 magnitude: simulated

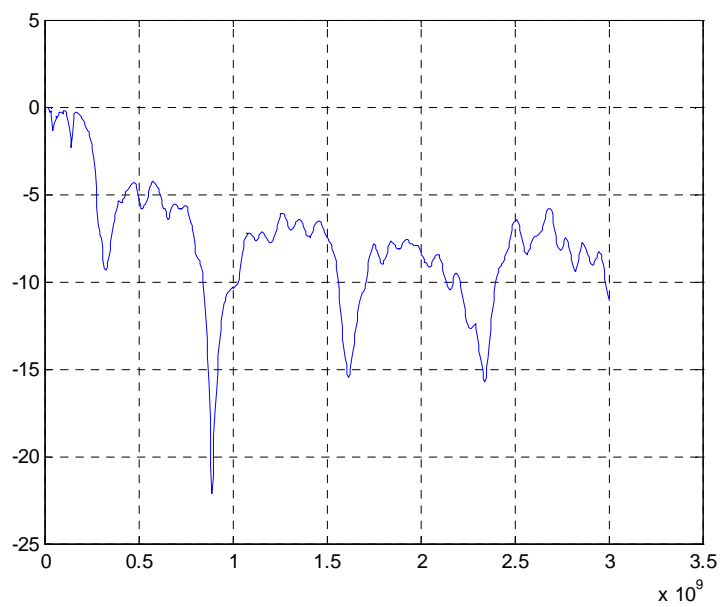
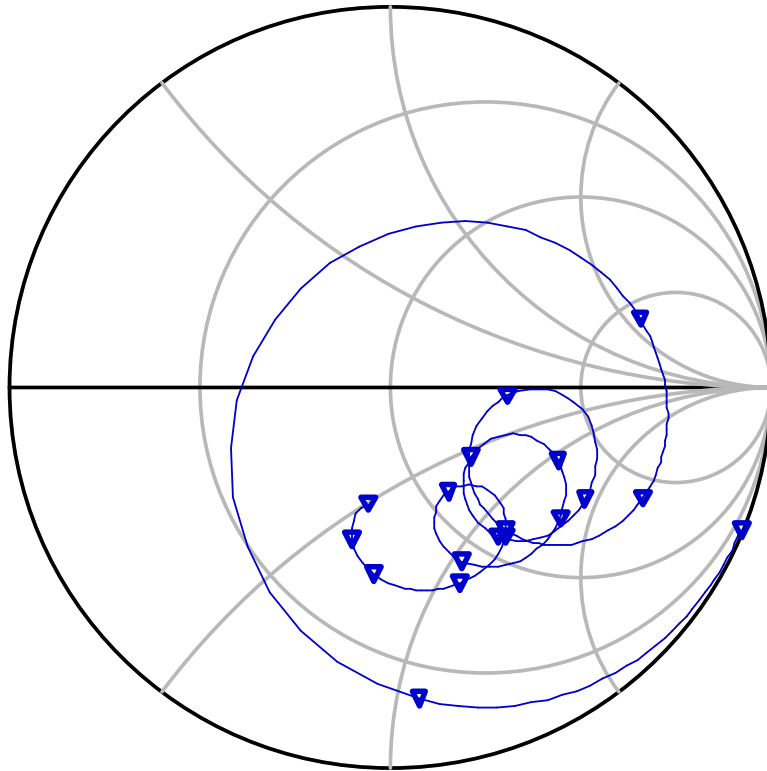


FIG.18 S11 magnitude: measured

S11



freq (100.0MHz to 3.000GHz)

FIG.19 Smith chart

## **CONCLUSIONS**

The capabilities of a bow-tie antenna to operate in UWB applications have been investigated. A bow-tie dipole for applications within the frequency range from 300 MHz to 3 GHz has been designed, simulated with ADS, and measured.

The experimental results are in good agreement with simulation.