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EEC 134
Application Note
Antenna
Team Radar

Antenna

Introduction
Antenna is the core component of the radar system. This application note is going to be on the antenna, and explain various types of antennas and their advantages and disadvantages, and antenna simulation. The main reasons why I chose to make an application note on antennas are 1) There was no application note on antennas on the EEC134 website, and 2) In the future some group may create their own antenna using aluminum that performs better and lighter than the coffee cans.

Types of Antennas
Most commonly used antennas include dipole antenna, loop antenna, horn antenna, and Yagi-Uda antenna. Dipole antenna is the simplest type of antenna and the main advantages include cheap price and it exhibits good gain. Similarly, loop antenna also have good gain and it is cheap. However, loop antennas have low radiation resistance which means impedance matching to a transmitter is hard. Horn antenna has many advantages. It has very high gain at high frequencies, ranging from 300MHz to 3Ghz. Not only that, horn antennas have good directional radiation pattern, and very low loss, which makes it the most favorable antenna for the radar project. Lastly, Yagi antenna also operates efficiently in high frequency range of 3MHz to 3GHz. Yagi antenna typically has small bandwidth, but it is cheap and very light.

Antenna Simulation
HFSS software which is installed in many Kemper labs can be used to measure various antenna parameters.

Step 1
Create a new project file and click the 'Insert' option then click insert 'HFSS Design'. Now the work place to draw antenna is created.

Step 2
Set solution type by clicking the option 'Solution Type' under 'HFSS', and check the box 'Driven Terminal'.

Step 3
Similar to most of 3D CAD software, using various drawing tools to draw antenna you want to simulate.

Step 4

Assigning excitation can be done by first drawing a rectangle at the position you want your excitation. Then click the rectangular plane, click 'Edit', click 'HFSS', click 'Excitations', click 'Assign', click 'Lumped Port', and select conductor as GND, check 'Use as Reference', and 'Highlight selected conductors', then click 'OK'.

Step 5
Creating an Air box to analyze radiation can be done by drawing a box bigger than your design and locate your antenna inside of the air box. Then assign the air box as boundary by clicking 'HFSS', and click 'Boundaries'.

Step 6
Now your antenna design is ready to be analyzed. Click 'HFSS', click 'Results', click 'Create Terminal Solution Data Report', and chose the type of plot you want. Now many parameters of antenna including the gain, directivity, S-Parameters, radiation patterns, and many more.

Horn Antenna Analysis Example

By sampling googling Pyramid Horn Antenna equations, one can easily obtain dimensional parameters for certain gain at desired frequency. Or simply horn antenna calculator can be used.

Horn Antenna Calculator: http://www.rfwireless-world.com/calculators/Horn-Antenna-Calculator.html

With calculated dimensional parameters, designed antenna can be drawn on HFSS and be simulated.
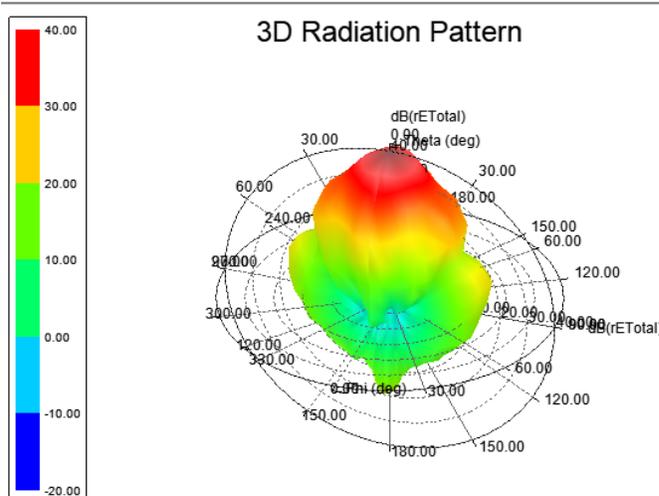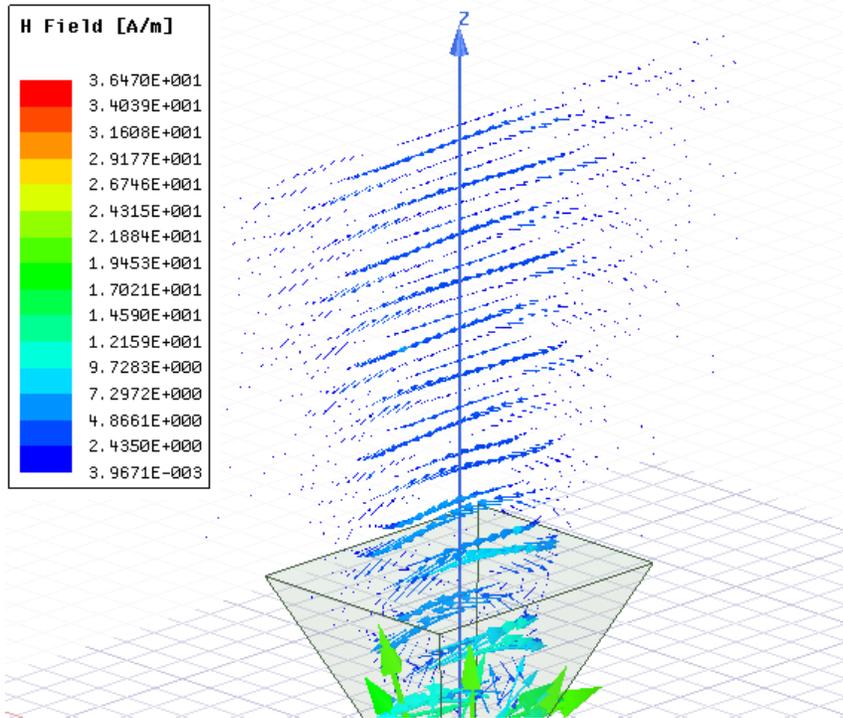

Fig 1. 3D Radiation Pattern
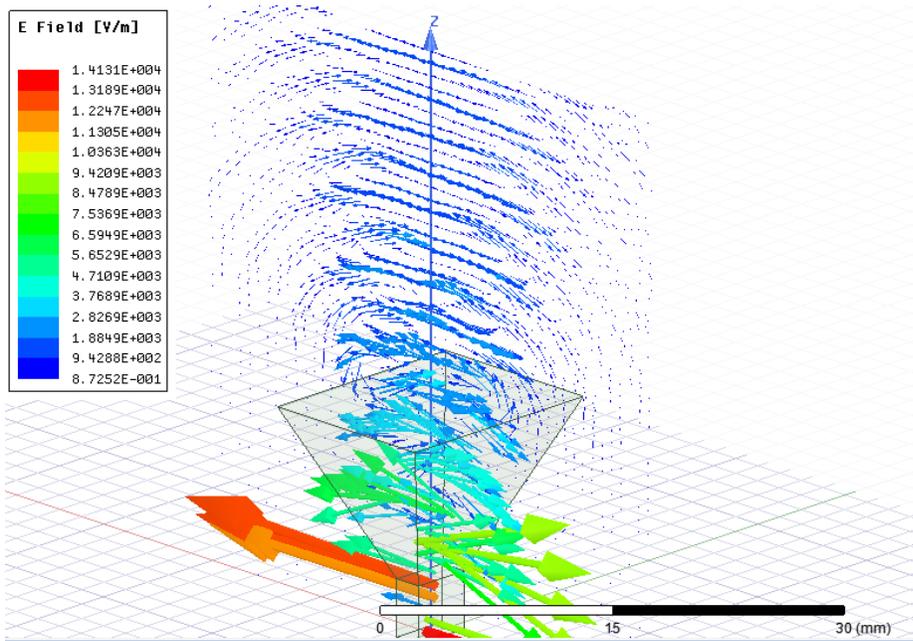
Fig 2. H-Field vector on Y-Axis plane

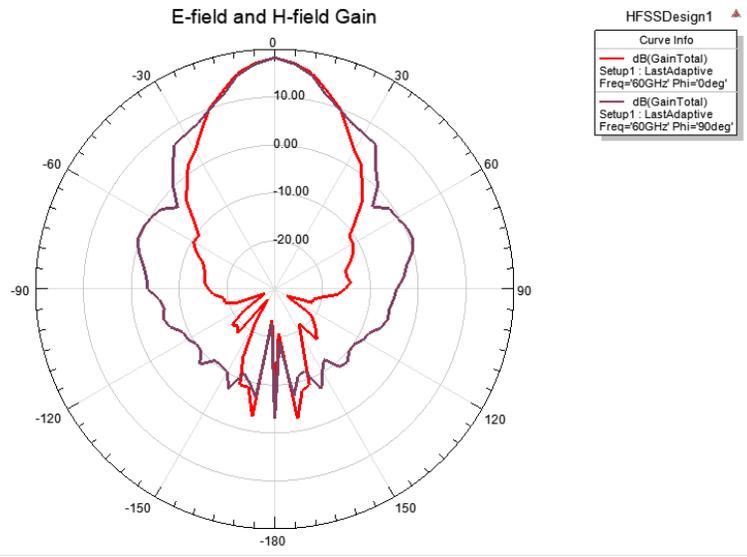Fig 3. E-field vector on X-axis plane
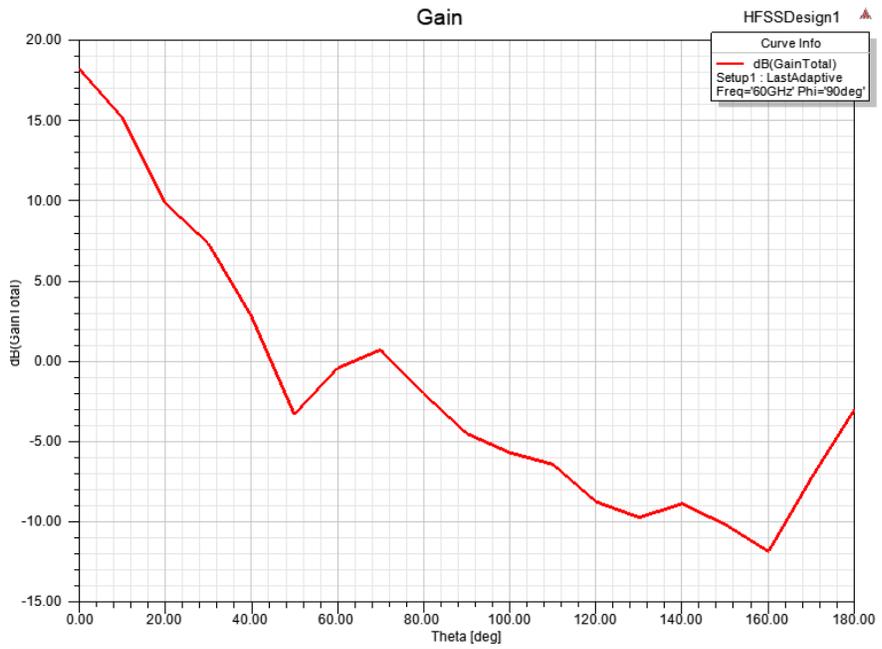
Fig 4. E-plane and H-plane Gain
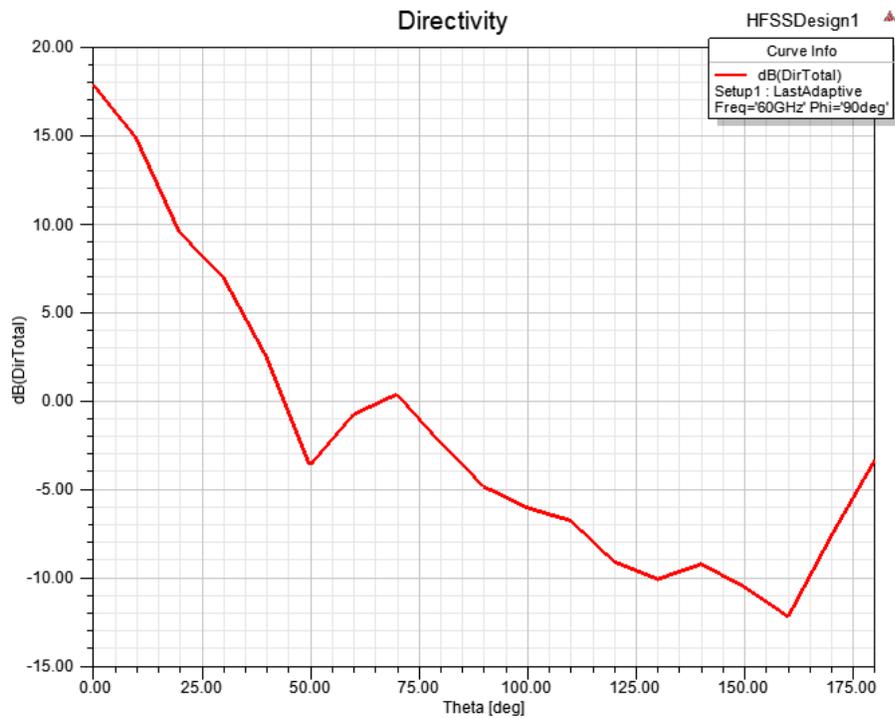

Fig. 5 Gain of Antenna
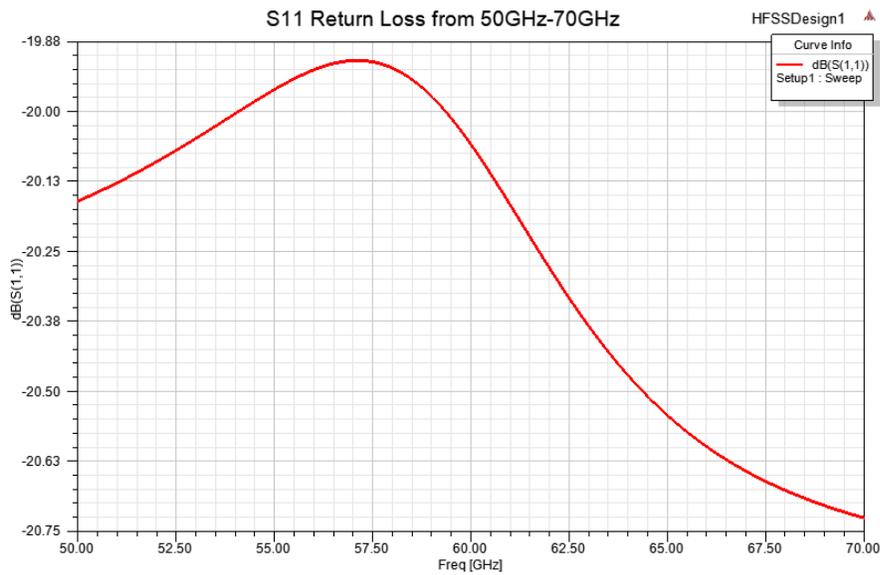
Fig. 6 Directivity of Antenna

Fig. 7 S11 Return Loss

Conclusion

Similar to my horn antenna simulation, any team who want to design their own antenna appropriate for their need can follow my application note and design an antenna and simulate it on HFSS.