Understanding Antenna's Radiation Pattern

Introduction

A basic understanding of antenna radiation patterns is very useful for correctly positioning your wireless devices, in order to ensure the most ideal transmission quality. This is even more important when doing protocol analyzer captures. This document will provide some basic information about radiation patterns of various antenna types.

Radiation Pattern Concept

When transmitting, an antenna will not radiate power equally in all directions. The shape of this power transmission is called the *radiation pattern*. This pattern is primarily the result of the antenna's construction, and can be determined either by simulation or by measurement.

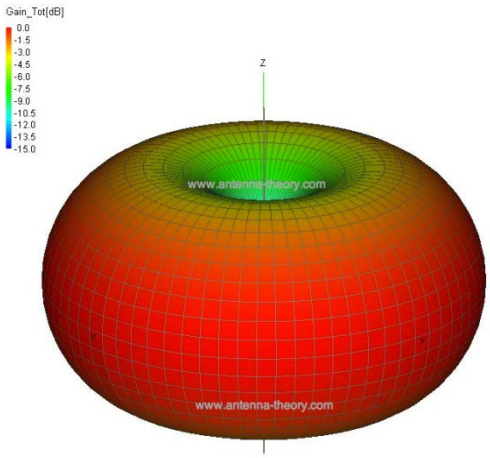
The easiest way to understand this pattern is to visualize it in a 3D space, but unfortunately this representation is not normally available from typical datasheets of off-the-shelf devices. Luckily there are not that many different antenna shapes used on *Bluetooth* devices.

Antenna Types

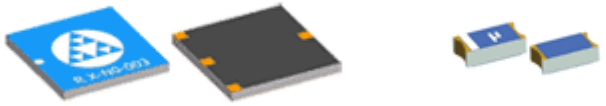
We will specifically cover omnidirectional antennas, as this is the most common form of antennas found on Bluetooth devices.

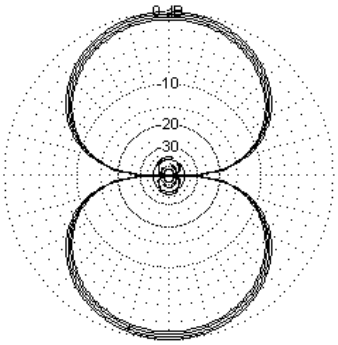
In a perfect world, an omnidirectional antenna would transmit the exact same power in all directions. In that case, this perfect antenna would create a spherical pattern. Unfortunately, such a perfect antenna does not exist. All antennas are imperfect and some positions are less ideal or even unusable. In addition, with the increasing prevalence of miniaturized devices, engineers often need to trade antenna quality to satisfy other constraints.

When transmission quality is more important than size, a detachable antenna with an SMA connector is usually used. These **stick antennas** are very common, and are also the most intuitive antennas, as their radiation pattern is more or less as we would expect. When positioned vertically, this antenna type will transmit the same amount of power all around (laterally), but not along its vertical axis (not on the top or bottom). This radiation pattern is known as *radial*, but visualized in a 3D space it looks more like a donut:



When space is the major constraint, **chip antennas** are good alternatives. This type of antenna is found on mobile phones, dongles, and anything that must be compact and flat. The pattern of these antennas usually looks like a 8, as shown below:





A mobile phone using such an antenna transmits nicely in front and behind its screen, but transmits a very poor signal on its sides. If you place this mobile phone flat on a table, it will provide the worst possible transmission quality. This is unfortunately how mobile phones are usually placed when doing quick tests in the lab, resulting in poor transmission quality and incomplete wireless analyzer captures.

For more information on correct placement of Bluetooth devices, please read the "Placing Correctly Your Analyzer" Expert Note.

Feedback

Feedback on our Expert Notes is always appreciated. To provide comments or critiques of any kind on this paper, please feel free to contact us at expert@ellisys.com.

Other interesting readings

- EEN_BT03 - Your First Wide-Band Capture
- EEN_BT04 - Optimal Placement of Your Analyzer
- EEN_BT05 - Understanding Antenna's Radiation Pattern
- More Ellisys Expert Notes available at: http://www.ellisys.com/technology/expert_notes.php

Rev. A. Updated 2011-05-16